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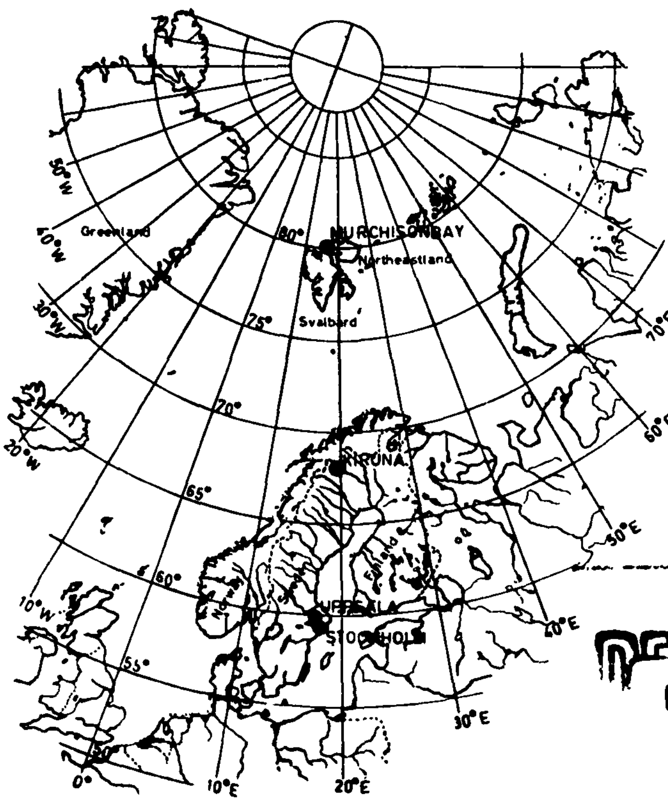

Uppsala, Sweden

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Uppsala, Sweden

FORBUSH DECREASES
Sep. 1 1956 - Dec. 31, 1959
HOURLY AND QUARTER-HOURLY DIAGRAMS

by Arne Eld Sandström

Technical Note No. 5
Contract No. AF 61(514)-1312

March 30, 1961

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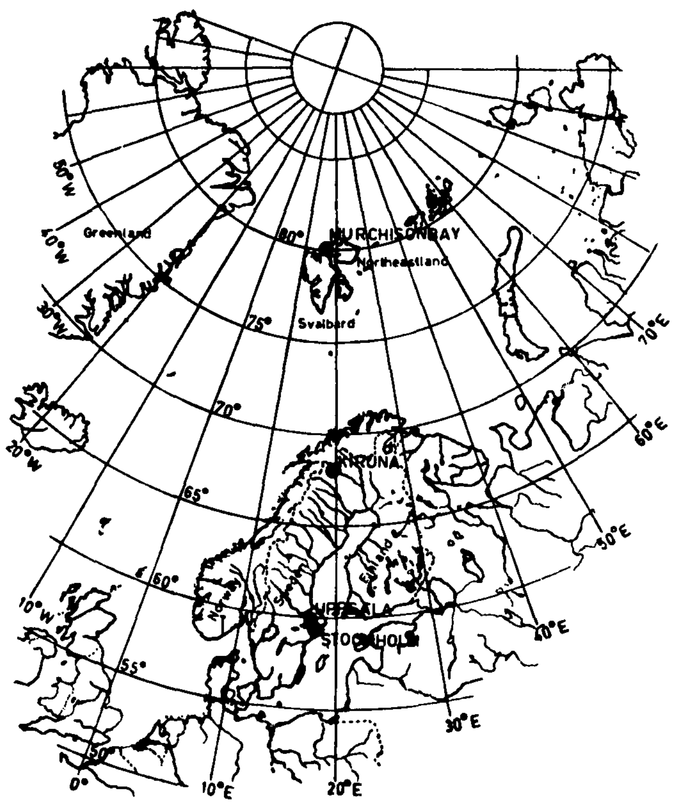

Uppsala, Sweden

Abstract

Part I of this note consists mainly of a collection of tables and diagrams concerning Forbush decreases during the period Sept. 1, 1956 to Dec. 31, 1959. Bihourly diagrams of all C.R. storms recorded during this period were reproduced in Technical Note No. 4. In the present note hourly and quarter-hourly values are presented for some of the most remarkable of these decreases.

In Part II is being discussed if certain characteristic details of C.R. storms, as registered by 8 separate instruments in Uppsala and Murchison Bay, can be regarded as simultaneous or not. The ratios between the variations of the meson and nucleon components have been calculated for the Uppsala and Murchison Bay stations. Some conclusions are being drawn. The lapse of time between s.s.c:s and correlated Forbush decreases has been studied.

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Part I: TABLES AND DIAGRAMS OF HOURLY AND QUARTER-HOURLY VALUES DURING FORBUSH DECREASES.

1. Introduction

At first it was contemplated to furnish hourly values corresponding to all the bihourly diagrams reproduced in Technical Note No 4. As in the latter case the values were calculated in per cent of the mean counting rate for the "calm" periods preceding the decreases (3rd column, Table 1, Techn. Note No 4). It turned out, however, that in many cases the hourly diagrams did not offer any information in addition to that already available from the bihourly diagrams. Accordingly, Part I of this note includes data only concerning decreases where something can be gained by increasing the resolution.

In general, quarter-hourly diagrams are of no interest unless the steep part of the decrease is at least 3 per cent. However, in certain cases rapid fluctuations are revealed, which cannot be ascribed solely to statistics. Therefore, quarter-hourly data have been studied for some small decreases also.

2. The statistical fluctuations

Concerning the bihourly values the magnitude of the statistical fluctuations have been listed in Table 1 of Techn. Note No 4. From the said magnitudes we find that as regards the hourly data the statistical fluctuations will be in per cent of the mean counting rates:

for the standard neutron pile monitors	0.64
for the standard cubical counter telescopes	0.31
for the inclined counter telescopes	0.41

Accordingly the corresponding figures for the quarter-hourly data will be 1.3; 0.6; and 0.8 per cent.

The statistical fluctuations will increase considerably if any channels have to be cut out owing to instrumental deficiencies. In general, care has been taken not to include such parts of the available data. In some instances it could not be avoided. Table 3 in Techn. Note No 4 makes it possible to identify these cases and to find the factor with which to multiply the figures for the statistical fluctuations.

3. Tables and diagrams

The figures are numbered B 1 - B 33, the A-numbers being reserved for bihourly diagrams. B 1 - B 33 refer to hourly as well as quarter-hourly data. From the Table of contents on pp. 1 and 2, it is possible to find the figure corresponding to anyone of the bihourly diagrams in Techn.Note No 4. In Tables 1 to 16 those data are collected which can be of interest in the future although, at present, curves are unimportant. The lettering of the curves (NM, Z, N, S, E, W) as well as the indexing of these letters (NM_U, Z_{MB}, etc.) is explained in Table 1 of Techn. Note No 4.

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Table 1

(A 2) 1956, Sept.: 8 d 10 h - 10 d 04 h. 1-hr values
UPPSALA

Day	Period	NM	E	W
8	10-11	100.1	100.3	100.9
	11-12	101.1	100.8	100.8
	12-13	102.6	99.7	100.1
	13-14	99.0	99.4	100.2
	14-15	100.2	99.8	99.8
	15-16	99.1	99.8	100.0
	16-17	99.2	99.5	98.6
	17-18	99.2	100.2	99.3
	18-19	99.9	100.9	99.5
	19-20	98.4	99.8	99.1
	20-21	98.6	99.5	98.8
	21-22	97.8	98.7	98.2
	22-23	97.2	97.9	98.9
	23-24	94.5	98.1	98.9
9	00-01	96.3	97.3	97.6
	01-02	97.0	97.5	98.1
	02-03	95.2	97.6	98.4
	03-04	94.4	98.1	98.0
	04-05	95.8	98.6	97.9
	05-06	96.9	98.7	98.1
	06-07	95.9	97.9	99.3
	07-08	96.7	98.8	98.2
	08-09	96.7	98.9	98.5
	09-10	96.1	99.1	98.2
	10-11	98.1	99.7	98.8
	11-12	99.4	100.8	99.2
	12-13	99.2	100.4	99.7
	13-14	99.5	100.2	99.1
	14-15	98.5	99.8	100.5
	15-16	98.5	99.2	100.2
	16-17	97.2	100.1	98.8
	17-18	98.2	99.1	100.0
	18-19	97.7	99.1	99.4
	19-20	98.0	98.5	98.8
	20-21	98.5	99.5	99.4
	21-22	96.0	99.6	99.0
	22-23	97.2	98.9	98.0
	23-24	95.7	98.0	98.8
10	00-01	96.2	98.5	98.6
	01-02	96.5	98.3	98.4
	02-03	96.5	97.7	98.7
	03-04	94.8	98.5	98.2

Table 2

(A 3) 195´. Nov.: 9 d 13 h 10 d 02 h. 15 min. values.
UPPSALA NM

Day	Hour	00-15	15-30	30-45	45 60
9	13-14	104.4	104.6	104.7	105.8
	14 15	101.8	103.2	103.3	102.6
	15-16	104.7	101.5	103.5	99.9
	16-17	101.6	97.6	100.9	100.5
	17-18	101.6	98.5	101.7	100.9
	18-19	100.6	102.2	104.3	100.5
	19-20	100.6	99.3	101.5	99.3
	20 21	102.9	99.8	100.9	100.9
	21-22	99.6	97.3	95.8	95.2
	22-23	94.5	98.6	97.7	99.8
	23-24	95.1	97.0	91.4	94.5
	00-01	94.9	94.1	95.5	96.1
	01-02	94.7	96.3	96.3	93.1

Table 3

(A 9) 1957. March 9 d 12 h - 10 d 24 h. 1 hr values
UPPSALA: NM

Day	Period	1st	2nd	3rd	4th	5th	6th
				hour in period			
9	12-18	100.0	100.2	102.2	100.5	100.4	100.6
	18-24	102.2	98.9	99.7	101.4	103.5	101.2
10	00-06	98.1	99.4	100.1	100.0	97.9	99.2
	06-12	99.5	99.1	97.7	97.5	96.9	94.7
	12-18	95.2	96.7	97.3	95.5	96.8	97.5
	18-24	96.6	94.7	95.7	93.4	94.0	94.1

Table 4

(A 17) 1957, Aug. 29 d 10 h - 30 d 03 h. 15-min. values.

UPPSALA

Meson component Z

Day	Hour	00-15	15-30	30-45	45-60
29	10-11	100.9	98.1	101.3	100.7
	11-12	99.6	100.4	101.0	100.9
	12-13	99.9	98.5	100.2	101.7
	13-14	101.0	99.3	100.9	100.4
	14-15	98.9	99.3	99.3	99.8
	15-16	99.8	99.8	101.2	99.3
	16-17	100.8	100.0	99.8	99.4
	17-18	100.5	99.9	100.9	102.3
	18-19	99.9	99.8	99.9	99.5
	19-20	100.8	100.4	100.2	100.7
	20-21	101.4	99.1	101.6	101.7
	21-22	102.5	102.1	99.5	99.9
	22-23	97.4	98.2	99.1	98.2
	23-24	97.3	98.0	95.8	97.4
30	00-01	95.2	95.2	95.2	95.7
	01-02	95.7	97.4	96.7	97.1
	02-03	97.3	94.8	96.1	96.8

Meson component E

Day	Hour	00-15	15-30	30-45	45-60
29	10-11	100.9	100.4	100.3	103.2
	11-12	100.6	98.7	101.8	99.3
	12-13	100.3	99.6	100.3	100.4
	13-14	100.2	100.1	100.1	100.6
	14-15	100.3	100.1	99.4	100.6
	15-16	100.4	99.7	99.5	101.0
	16-17	100.7	100.2	101.8	98.8
	17 18	100.2	100.0	99.8	100.9
	18-19	99.7	100.6	99.8	100.0
	19-20	100.8	100.7	99.9	102.7
	20-21	101.6	99.2	99.8	101.5
	21-22	101.7	99.8	100.0	98.6
	22-23	97.6	97.0	98.6	96.2
	23-24	97.5	96.4	96.0	97.4
30	00-01	95.9	95.8	96.2	96.8
	01-02	94.9	97.0	95.5	96.7
	02-03	96.6	95.8	96.7	98.2

Meson component W

Day	Hour	00-15	15-30	30-45	45-60
29	10-11	100.4	99.7	101.0	100.8
	11-12	99.3	100.0	100.5	100.6
	12-13	99.2	100.1	99.2	100.3
	13-14	101.9	100.5	101.0	98.6
	14-15	101.0	98.5	101.2	99.7
	15-16	98.4	100.7	100.8	100.7
	16-17	99.6	98.7	100.2	99.9
	17-18	100.0	100.1	102.4	99.8
	18-19	99.6	100.7	99.1	99.9
	19-20	101.3	100.4	100.2	99.1
	20-21	100.3	99.1	99.9	102.7
	21-22	100.2	98.7	99.6	98.9
	22-23	98.4	98.9	98.1	98.6
	23-24	98.3	96.9	95.8	96.5
30	00-01	96.0	95.8	94.8	97.5
	01-02	98.3	97.2	96.8	97.7
	02-03	95.5	97.2	98.4	96.6

Table 5

(A 17, A 18) 1957, Aug.: 30 d 03 h - 31 d 00 h. 1-hr values
UPPSALA

Day	Period	1st	2nd	3rd	4th	5th	6th
				Meson component Z			
30	00-06				96.0	96.0	96.3
	06-12	97.6	96.9	97.8	98.0	96.0	96.4
	12-18	95.8	96.4	95.7	96.8	96.6	96.1
	18-24	96.1	96.4	95.5	95.4	95.8	95.5
				Meson component E			
30	00 06				96.5	97.1	96.4
	06-12	97.1	96.3	97.1	97.1	96.2	96.2
	12-18	96.2	98.2	97.1	97.0	96.7	97.4
	18-24	96.0	96.2	95.7	96.3	96.5	96.4
				Meson component W			
30	00-06				96.0	96.1	96.7
	06-12	96.3	96.5	96.2	96.8	95.8	95.9
	12-18	96.0	95.2	96.2	96.0	95.4	95.6
	18-24	95.7	95.7	95.9	95.1	96.0	95.7

Table 6

(A 17, A 18) 1957, Aug.: 29 d 10 h - 31 d 00 h. 1-hr values
KIRUNA

Day	Period	1st	2nd	3rd	4th	5th	6th
				Meson component Z			
29	06-12					100.7	99.4
	12-18	101.1	100.7	100.7	99.3	99.5	98.9
	18-24	100.3	101.6	100.8	100.1	98.7	96.5
30	00-06	97.1	95.5	96.9	95.9	96.5	96.9
	06-12	96.4	97.3	96.7	97.1	97.1	96.7
	12-18	97.3	96.1	95.6	96.9	95.9	95.8
	18-24	95.4	95.0	95.7	95.7	94.0	96.2
				Meson component N			
29	06-12					100.8	100.2
	12-18	100.9	100.9	100.8	100.6	100.6	100.1
	18-24	100.4	100.9	100.7	100.1	98.0	96.6
30	00-06	97.2	96.7	97.2	97.2	97.4	97.0
	06-12	97.4	96.7	97.2	97.7	97.0	97.3
	12-18	97.1	96.5	96.9	96.9	96.2	96.5
	18-24	96.2	95.7	95.5	95.9	95.8	96.3
				Meson component S			
29	06-12					101.1	101.1
	12-18	101.9	100.6	101.1	100.6	100.8	100.0
	18-24	100.9	100.1	100.7	99.7	98.3	98.7
30	00-06	97.9	96.7	96.6	96.8	97.0	96.7
	06-12	96.6	97.7	97.3	97.5	97.7	96.2
	12-18	96.5	96.4	96.8	96.7	96.9	96.5
	18-24	96.7	96.0	95.5	95.2	96.1	95.7

Table 7

(A 16) 1957, Sept.: 02 d 00 h - 03 d 12 h. 1-hr values.
UPPSALA NM

Day	Period	1st	2nd	3rd	4th	5th	6th
02	00-06	91.7	93.1	93.5	93.0	93.3	92.9
	06-12	91.9	90.6	91.2	92.4	93.3	93.3
	12-18	93.4	93.9	93.9	93.3	91.5	90.6
	18-24	89.7	89.7	88.0	88.1	87.6	89.0
03	00-06	89.8	88.6	88.0	88.9	89.9	90.3
	06-12	91.4	89.3	91.4	91.0	90.3	90.7

Table 8

(A 28 A 30) 1957, Oct.: 21 d 22 h - 22 d 07 h. 15 min.-values

UPPSALA NM

Day	Hour	00-15	15-30	30-45	45- 0
21	22-23	101.4	100.5	104.0	100.4
	23-24	100.4	99.2	98.4	98.1
22	00-01	97.3	97.3	95.4	99.4
	01-02	96.7	96.0	96.6	98.4
	02-03	99.0	94.5	94.6	94.7
	03-04	97.2	97.3	95.7	94.9
	04-05	98.5	95.5	99.9	100.5
	05-06	97.3	97.1	97.9	96.3
	06-07	99.4	98.8	98.6	98.3

MURCHISON BAY NM

Day	Hour	00-15	15-30	30-45	45-60
21	22-23	101.8	103.7	104.7	100.7
	23-24	103.1	103.6	98.6	98.0
22	00-01	99.9	100.2	100.6	98.0
	01-02	99.5	97.7	98.0	98.6
	02-03	96.2	99.2	96.9	98.1
	03-04	95.1	97.0	97.7	97.8
	04-05	97.3	94.7	96.6	95.4
	05-06	96.6	97.2	93.5	97.9
	06-07	95.8	95.3	98.8	95.1

Table 9

(A 28, A 29, A 30) 1957, Oct.: 21 d 22 h - 22 d 02 h. 15-min. **values**

UPPSALA — Meson component Z

Day	Hour	00-15	15-30	30-45	45-60
21	22-23	100.7	99.6	99.3	101.0
	23-24	101.4	99.0	99.3	98.5
22	00-01	99.3	97.0	96.0	97.5
	01-02	96.7	95.4	97.9	96.9

MURCHISON BAY

Day	Hour	00-15	15-30	30-45	45-60
21	22-23	103.1	102.3	100.6	101.8
	23-24	102.6	103.0	101.0	101.8
22	00-01	100.6	99.3	100.6	98.5

KIRUNA

Day	Hour	00-15	15-30	30-45	45-60
21	22-23	100.8	100.9	101.9	101.5
	23-24	100.7	99.9	99.9	98.5
22	00-01	98.3	99.4	97.0	96.6
	01-02	96.6	98.0	98.0	96.4

UPPSALA — Meson component E

Day	Hour	00-15	15-30	30-45	45-60
21	22-23	100.4	99.8	100.9	101.3
	23-24	100.5	100.2	98.7	99.4
22	00-01	98.9	97.5	97.8	98.1
	01-02	97.0	96.6	98.5	97.2

MURCHISON BAY

Day	Hour	00-15	15-30	30-45	45-60
21	22-23	101.2	100.9	102.6	99.7
	23-24	100.9	101.3	100.5	99.9
22	00-01	97.2	99.1	98.5	98.2
	01-02	98.9	98.3	98.3	98.3

UPPSALA — Meson component W

Day	Hour	00-15	15-30	30-45	45-60
21	22-23	100.5	101.8	103.0	100.9
	23-24	101.3	100.9	101.5	100.5
22	00-01	99.4	98.5	98.8	98.3
	01-02	98.8	97.6	98.7	97.7

MURCHISON BAY

Day	Hour	00-15	15-30	30-45	45-60
21	22-23	102.0	100.7	101.8	100.3
	23-24	101.9	100.4	101.5	99.3
22	00-01	100.3	99.4	100.4	97.6
	01-02	100.7	99.7	99.4	98.0

Continued overleaf

Table 9 (continued)

(A 28, A 29, A 30) 1957, Oct.: 21 d 22 h - 22 d 02 h. 15 min.-values.
KIRUNA

Day	Hour	00-15	15-30	30-45	45-60
			Meson component N		
21	22-23	100.7	100.0	100.6	100.3
	23-24	98.8	100.0	98.7	97.0
22	00-01	96.5	98.7	98.4	96.7
	01-02	97.0	97.8	97.4	97.3

Day	Hour	00-15	15-30	30-45	45-60
			Meson component S		
21	22-23	101.4	99.4	101.1	101.2
	23-24	100.5	99.1	100.5	99.1
22	00-01	99.0	98.1	97.4	96.4
	01-02	92.9	96.6	97.1	95.4

Table 10

(A 42) 1958, March: 25 d 15 h - 28 d 12 h. 1-hr values.
UPPSALA

Day	Period	1st	2nd	3rd	4th	5th	6th
				NM			
25	12-18			100.5	100.7	99.3	97.7
	18-24	96.4	95.9	95.2	95.1	93.8	93.6
26	00-06	92.3	95.0	94.4	93.8	93.4	93.6
	06-12	93.3	93.0	94.5	95.0	94.8	94.1
	12-18	93.3	94.6	93.4	94.1	92.0	92.0
	18-24	93.1	91.8	91.8	93.0	93.3	94.2
27	00-06	92.8	92.7	95.0	93.8	93.6	93.9
	06-12	92.9	95.3	93.7	94.8	93.9	95.4
	12-18	94.4	94.3	93.0	95.4	95.6	98.4
	18-24	94.3	95.1	95.2	94.0	94.2	91.6
28	00-06	92.8	94.1	93.0	93.3	94.1	94.6
	06-12	93.7	94.2	95.3	95.4	94.0	95.0

Day	Period	1st	2nd	3rd	4th	5th	6th
				Meson component Z			
25	12-18			100.2	99.7	100.2	100.1
	18-24	98.1	96.2	96.2	95.6	95.0	95.4
26	00-06	95.8	96.1	95.8	96.0	96.1	96.7
	06-12	96.1	96.0	97.0	97.0	97.0	97.1
	12-18	96.9	96.4	96.4	96.1	95.6	95.1
	18-24	95.2	95.1	95.3	95.7	96.5	96.0
27	00-06	95.9	96.2	96.3	96.0	96.6	96.7
	06-12	97.1	96.7	97.3	97.7	97.4	97.1
	12-18	97.0	96.9	97.2	96.7	97.3	96.4
	18-24	96.6	96.9	96.8	96.4	96.5	96.3
28	00-06	96.2	96.2	96.2	96.2	96.2	96.3
	06-12	96.5	96.8	97.3	96.8	97.1	97.4

Continued overleaf

Table 10 (continued)

(A 42) 1958, March: 25 d 15 h - 28 d 12 h. 1-hr values.
UPPSALA

Day	Period	Meson component E					
		1st	2nd	3rd	4th	5th	6th
25	12-18			100.6	101.3	100.8	99.9
	18-24	98.3	98.0	97.8	97.1	96.5	96.1
26	00-06	96.7	97.0	97.1	97.4	97.6	97.8
	06-12	97.3	98.2	97.3	98.5	97.9	98.4
	12-18	98.4	98.1	99.0	96.7	95.9	95.9
	18-24	95.5	96.0	96.9	97.3	96.6	96.4
27	00-06	96.6	95.9	97.8	96.9	97.0	97.0
	06-12	97.1	97.9	97.7	98.3	99.4	98.2
	12-18	97.8	97.9	97.3	98.1	97.3	97.1
	18-24	98.0	97.9	97.5	96.4	96.9	96.8
28	00-06	96.8	97.0	98.4	97.0	97.3	97.5
	06-12	98.7	98.3	98.6	99.1	98.7	99.0

Day	Period	Meson component W					
		1st	2nd	3rd	4th	5th	6th
25	12-18			100.2	101.3	99.8	98.6
	18-24	98.1	98.1	98.2	96.9	96.7	96.2
26	00-06	96.3	96.0	96.8	96.6	96.5	96.5
	06-12	96.3	96.7	96.7	96.1	96.9	96.6
	12-18	96.5	96.8	97.5	96.2	97.5	96.3
	18-24	96.2	96.6	95.8	95.9	97.0	96.5
27	00-06	96.8	97.4	97.0	98.3	98.2	97.9
	06-12	98.1	97.9	98.4	98.2	99.0	98.6
	12-18	97.9	98.0	98.9	98.4	98.7	98.1
	18-24	98.3	98.8	98.1	98.2	98.1	97.5
28	00-06	97.8	97.5	97.9	97.9	98.0	98.4
	06-12	98.1	98.6	98.3	98.3	98.4	99.2

Table 11

(A 43) 1958, March: 25 d 15 h - 28 d 12 h. 1-hr values.
KIRUNA

Day	Period	Meson component Z					
		1st	2nd	3rd	4th	5th	6th
25	12-18			101.5	101.5	99.9	98.5
	18-24	97.5	97.8	97.4	96.9	95.9	95.5
26	00-06	95.5	96.8	97.6	97.0	97.3	96.9
	06-12	96.8	96.9	96.4	96.3	96.6	95.3
	12-18	95.8	96.1	96.2	96.3	96.2	96.4
	18-24	95.7	95.5	95.5	96.0	96.4	96.7
27	00-06	96.7	97.4	97.2	96.8	97.4	97.8
	06-12	97.8	98.1	98.7	98.5	98.7	97.8
	12-18	98.2	98.1	98.1	98.5	97.8	97.7
	18-24	98.3	97.5	97.5	96.8	96.8	96.9
28	00-06	96.4	96.6	96.7	97.9	97.1	97.9
	06-12	97.4	98.0	98.0	97.3	98.2	98.1

Continued overleaf

Table 11 (continued)

(A 43) 1958, March: 25 d 15 h - 28 d 12 h. 1-hr values.
KIRUNA

		Meson component N					
Day	Period	1st	2nd	3rd	4th	5th	6th
25	12-18			101.7	102.1	102.1	100.7
	18-24	99.5	100.2	99.3	98.7	97.8	98.5
26	00-06	99.1	99.0	99.3	98.7	98.7	98.5
	06-12	99.5	99.1	99.1	98.5	98.9	96.8
	12-18	97.1	98.0	97.8	97.5	98.3	97.9
	18-24	97.3	97.6	97.8	98.3	98.3	98.8
27	00-06	98.2	98.4	98.3	98.8	98.9	99.0
	06-12	100.5	100.2	99.9	99.6	99.4	99.5
	12-18	100.0	98.8	99.8	99.8	99.1	99.1
	18-24	98.7	99.1	99.0	98.3	99.1	99.4
28	00-06	98.8	98.9	98.4	99.0	99.5	99.3
	06-12	100.1	99.3	99.0	100.4	99.6	99.6

		Meson component S					
Day	Period	1st	2nd	3rd	4th	5th	6th
25	12-18			100.8	101.0	99.5	99.6
	18-24	98.5	97.4	97.8	97.6	95.7	96.0
26	00-06	95.6	96.4	96.9	96.4	97.4	97.3
	06-12	97.5	97.4	97.4	97.0	97.0	97.0
	12-18	96.3	97.2	97.9	97.3	97.6	97.1
	18-24	96.3	96.0	95.7	96.2	96.0	97.1
27	00-06	97.0	96.9	96.9	97.4	97.6	97.3
	06-12	97.6	97.9	97.6	97.3	99.2	99.3
	12-18	99.4	99.8	98.7	99.1	98.2	98.3
	18-24	98.3	97.4	97.8	97.8	97.8	97.5
28	00-06	97.2	96.8	97.5	97.5	97.1	97.6
	06-12	98.0	97.6	97.9	97.8	98.3	97.9

Table 12

(A 44) 1958, March: 25 d 15 h - 28 d 12 h. 1-hr values.
MURCHISON BAY

		NM					
Day	Period	1st	2nd	3rd	4th	5th	6th
25	12-18			101.0	100.9	99.0	96.1
	18-24	96.0	95.5	96.4	95.6	93.6	93.0
26	00-06	93.1	93.8	94.4	93.4	92.9	94.3
	06-12	92.6	93.1	91.0	92.9	92.2	92.0
	12-18	91.9	92.9	92.9	93.3	92.8	92.8
	18-24	92.8	93.2	91.9	93.0	92.3	93.9
27	00-06	93.2	93.0	94.2	94.5	93.0	94.5
	06-12	94.1	94.0	95.3	95.6	95.0	95.1
	12-18	95.5	94.9	95.2	94.5	94.8	96.0
	18-24	95.5	94.1	94.7	93.2	94.4	93.0
28	00-06	94.0	91.4	93.5	92.5	94.5	94.6
	06-12	93.7	94.8	94.2	93.5	94.1	93.0

Continued overleaf

Table 12 (continued)

(A 44) 1958, March: 25 d 15 h - 28 d 12 h. 1-hr values.
MURCHISON BAY

Meson component Z

Day	Period	1st	2nd	3rd	4th	5th	6th
25	12-18			100.9	101.0	100.0	98.8
	18-24	98.1	97.8	97.2	97.2	96.5	96.1
26	00-06	96.8	96.2	96.9	97.3	96.7	96.5
	06-12	96.9	96.2	96.6	96.3	95.9	96.2
	12-18	95.7	95.7	96.1	96.2	96.8	96.0
	18-24	96.0	96.6	96.7	96.9	96.8	97.1
27	00-06	96.7	97.1	97.2	97.4	97.3	97.5
	06-12	97.6	97.2	97.7	97.4	97.4	98.5
	12-18	97.8	98.3	97.8	98.2	97.5	97.8
	18-24	97.4	98.5	97.7	97.1	97.2	97.7
28	00-06	97.5	97.7	97.6	96.7	98.0	97.8
	06-12	97.9	97.4	97.8	98.1	98.0	97.5

Meson component E

Day	Period	1st	2nd	3rd	4th	5th	6th
25	12-18			100.6	101.1	100.7	97.7
	18-24	97.3	96.1	97.6	97.2	97.1	97.1
26	00-06	96.8	97.4	97.5	97.4	97.1	97.5
	06-12	97.1	97.6	98.4	98.7	97.5	96.8
	12-18	96.2	96.9	96.6	96.6	96.6	96.5
	18-24	96.1	96.6	96.6	97.2	96.3	97.1
27	00-06	97.6	97.9	97.5	96.9	97.4	97.5
	06-12	98.2	98.3	97.8	98.7	99.2	99.5
	12-18	98.5	98.6	97.6	97.7	98.0	98.0
	18-24	98.4	98.4	97.5	97.6	98.2	97.1
28	00-06	98.1	97.4	97.9	98.0	98.5	98.7
	06-12	97.9	98.3	98.3	99.6	98.2	98.4

Meson component W

Day	Period	1st	2nd	3rd	4th	5th	6th
25	12-18			99.8	100.0	99.4	98.2
	18-24	97.3	96.2	97.6	97.5	96.5	97.1
26	00-06	97.7	97.4	96.5	97.3	97.7	96.7
	06-12	95.6	96.1	96.7	95.9	96.6	96.5
	12-18	95.9	95.8	96.1	96.7	97.3	97.1
	18-24	97.0	96.9	96.8	97.0	96.9	96.8
27	00-06	97.0	98.1	97.7	97.6	97.9	96.5
	06-12	96.6	97.9	97.5	97.3	97.9	97.6
	12-18	96.8	97.1	98.1	97.6	97.5	98.4
	18-24	98.8	97.6	97.6	98.2	98.3	97.9
28	00-06	98.1	96.9	97.4	97.5	97.4	97.6
	06-12	97.4	97.8	97.4	97.5	97.2	97.4

Table 13

(A 56) 1958, July: 21 d 04 h - 22 d 00 h. 1-hr values.
MURCHISON BAY

Day	Period	1st	2nd	3rd	4th	5th	6th
21	00-06					100.2	100.2
	06-12	100.9	101.2	101.1	101.5	102.3	100.1
	12-18	101.3	99.3	100.9	100.3	101.0	101.6
	18-24	100.7	99.7	96.4	98.7	97.4	97.8
22	00-06	96.2	96.4	97.6	96.5	96.4	95.8
	06-12	98.1	97.9	96.5	98.9	97.0	98.8
	12-18	97.8	99.0	98.5	98.4	98.1	99.7
	18-24	98.0	97.8	97.2	98.4	97.5	98.4

Table 14

(A 59 A 60) 1958, Aug.: 24 d 00 h - 24 d 09 h. 15 min.-values.

UPPSALA NM

Day	Hour	00-15	15-30	30-45	45-60
24	00-01	98.2	98.3	99.8	99.6
	01-02	100.1	99.2	98.5	98.3
	02-03	98.1	98.0	94.4	96.0
	03-04	94.6	93.9	97.5	96.2
	04-05	94.8	95.1	97.6	94.2
	05-06	95.5	90.7	90.2	92.8
	06-07	89.3	90.4	91.2	90.5
	07-08	92.2	93.5	91.4	91.6
	08-09	90.3	92.9	90.6	92.6

MURCHISON BAY NM

Day	Hour	00-15	15-30	30-45	45-60
24	00-01	98.3	95.1	101.7	96.8
	01-02	102.2	97.1	97.3	101.6
	02-03	100.5	102.8	97.2	97.7
	03-04	99.2	100.0	97.2	97.3
	04-05	99.8	96.9	97.9	96.7
	05-06	94.1	98.6	97.5	93.7
	06-07	93.5	92.5	91.7	93.7
	07-08	92.2	92.3	91.1	93.0
	08-09	94.6	93.3	93.5	92.7

Table 15

(A 105 A 106) 1959, Sept.: 3 d 09 h - 4 d 05 h. 1-hr values.

UPPSALA NM

Day	Period	1st	2nd	3rd	4th	5th	6th
3	06-12			99.7	100.7	102.0	100.7
	12-18	102.1	100.4	100.0	99.5	99.1	100.0
	18-24	97.7	97.3	98.6	97.8	97.4	97.6
4	00-06	95.1	95.8	99.2	94.0	95.5	

Continued overleaf

Table 15 (continued)

(A 105 A 106) 1959, Sept.: 3 d 09 h - 4 d 05 h. 1-hr values.

UPPSALA — Meson component Z

Day	Period	1st	2nd	3rd	4th	5th	6th
3	06-12			99.4	100.1	100.2	100.1
	12-18	100.6	99.6	99.9	98.9	99.0	99.0
	18-24	99.3	99.1	98.8	98.6	98.2	97.2
4	00-06	98.5	99.4	96.9	96.3	97.4	

KIRUNA

Day	Period	1st	2nd	3rd	4th	5th	6th
3	06-12			100.7	100.8	100.9	101.0
	12-18	100.6	100.1	100.1	100.2	99.9	100.6
	18-24	100.4	100.1	99.3	99.1	98.4	98.8
4	00-06	98.2	97.7	98.0	98.6	98.4	

UPPSALA — Meson component E

Day	Period	1st	2nd	3rd	4th	5th	6th
3	06-12			99.9	100.6	100.9	100.4
	12-18	100.3	99.4	100.3	100.3	100.2	99.9
	18-24	100.4	99.6	99.6	99.6	99.6	98.2
4	00-06	98.7	98.2	98.7	97.6	100.3	

Meson component W

Day	Period	1st	2nd	3rd	4th	5th	6th
3	06-12			100.4	101.4	100.4	101.4
	12-18	100.5	100.4	99.7	100.2	100.3	99.7
	18-24	100.1	100.2	99.7	99.1	98.9	98.9
4	00-06	98.8	98.7	98.1	98.1	98.0	

KIRUNA — Meson component N

Day	Period	1st	2nd	3rd	4th	5th	6th
3	06-12			99.9	100.3	100.2	100.9
	12-18	100.1	101.0	99.9	99.9	99.7	100.5
	18-24	100.8	99.4	100.0	99.6	98.0	98.5
4	00-06	99.3	98.5	98.5	97.8	97.6	

Meson component S

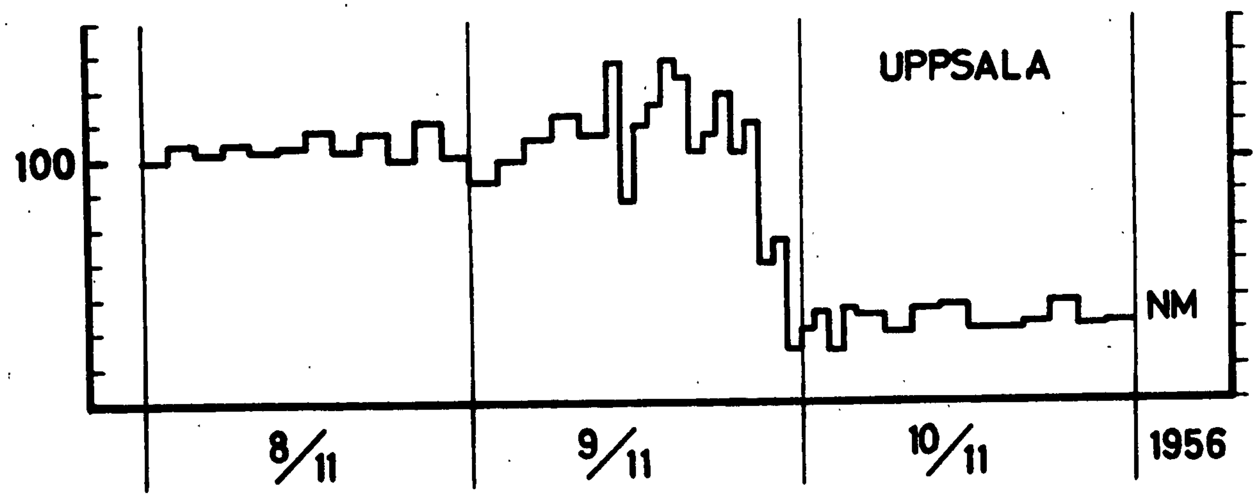
Day	Period	1st	2nd	3rd	4th	5th	6th
3	00-12			100.9	100.0	99.7	100.1
	12-18	100.1	100.7	100.3	99.9	100.7	100.3
	18-24	100.3	99.2	100.1	100.0	98.3	98.5
4	00-06	97.7	98.1	97.6	97.9	97.4	

Table 16

(A 116) 1959, Dec.: 23 d 19 h - 24 d 21 h. 1-hr values

UPPSALA NM

Day	Period	1st	2nd	3rd	4th	5th	6th
23	18-24	98.2	99.6	99.2	98.3	99.4	97.8
24	00-06	98.0	97.2	95.4	95.6	94.8	95.3
	06-12	97.3	95.4	94.7	96.2	97.8	96.6
	12-18	97.1	97.5	96.7	97.1	96.5	95.2
	18-24	94.2	96.3	96.7			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9/11
10/11
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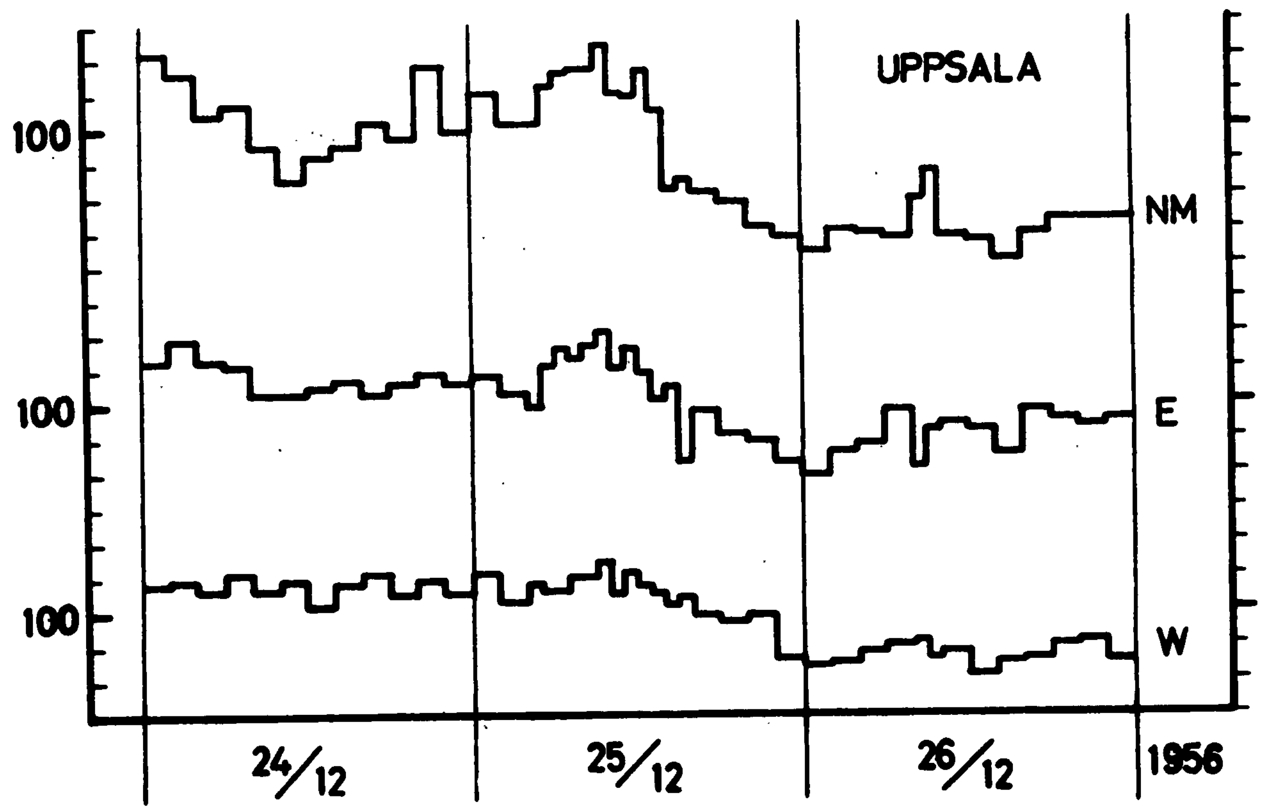
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E
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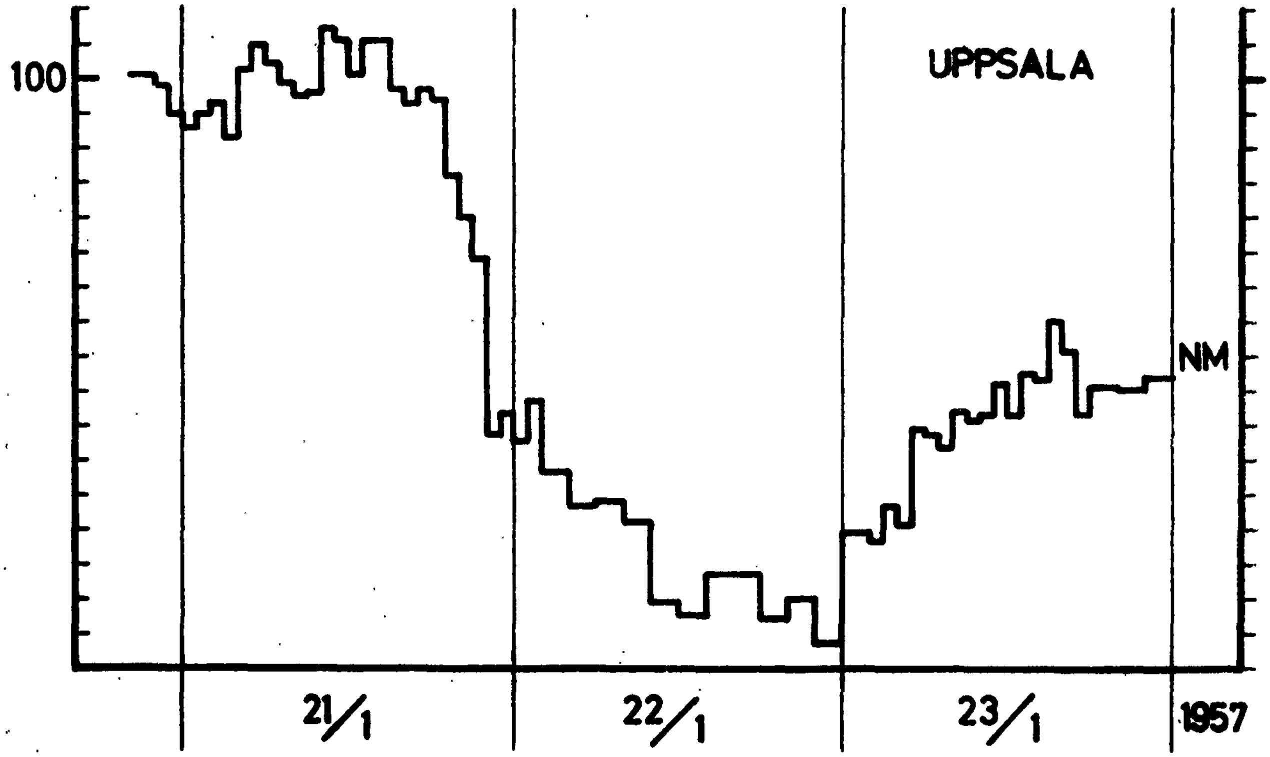
W
24/12
25/12
26/12
1956



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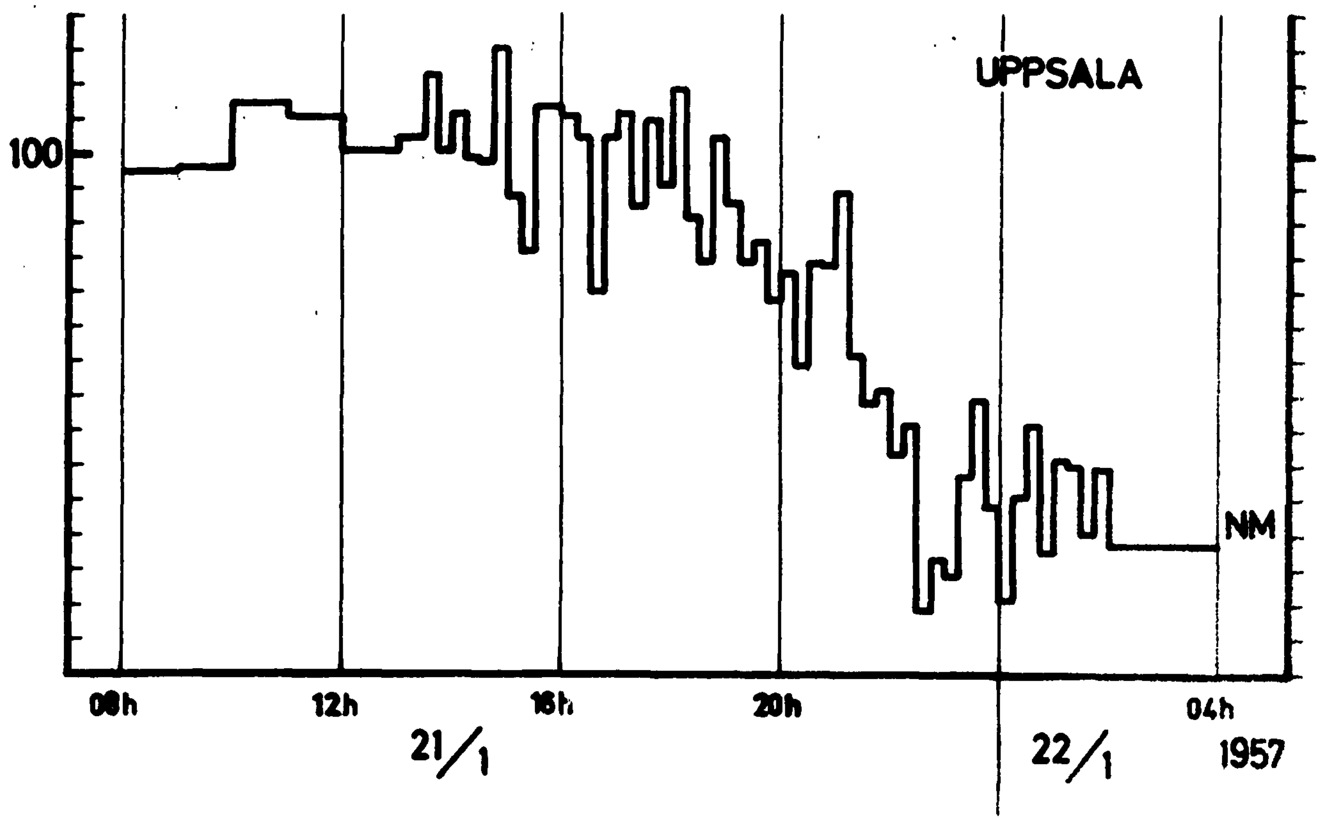
22/1
23/1
1957



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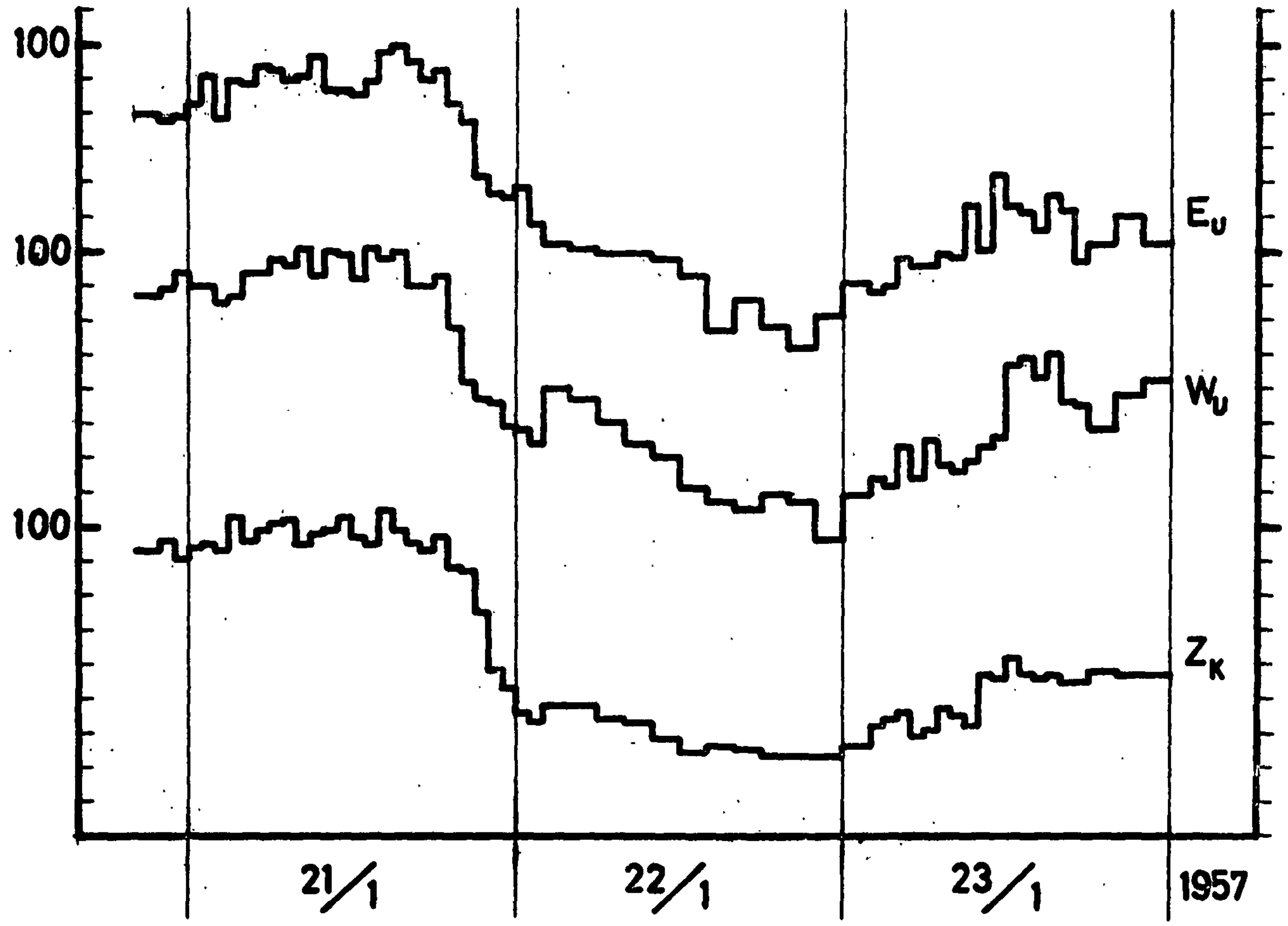
16h
20h
04h
21/1
22/1
1957



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100
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W_U
Z_K
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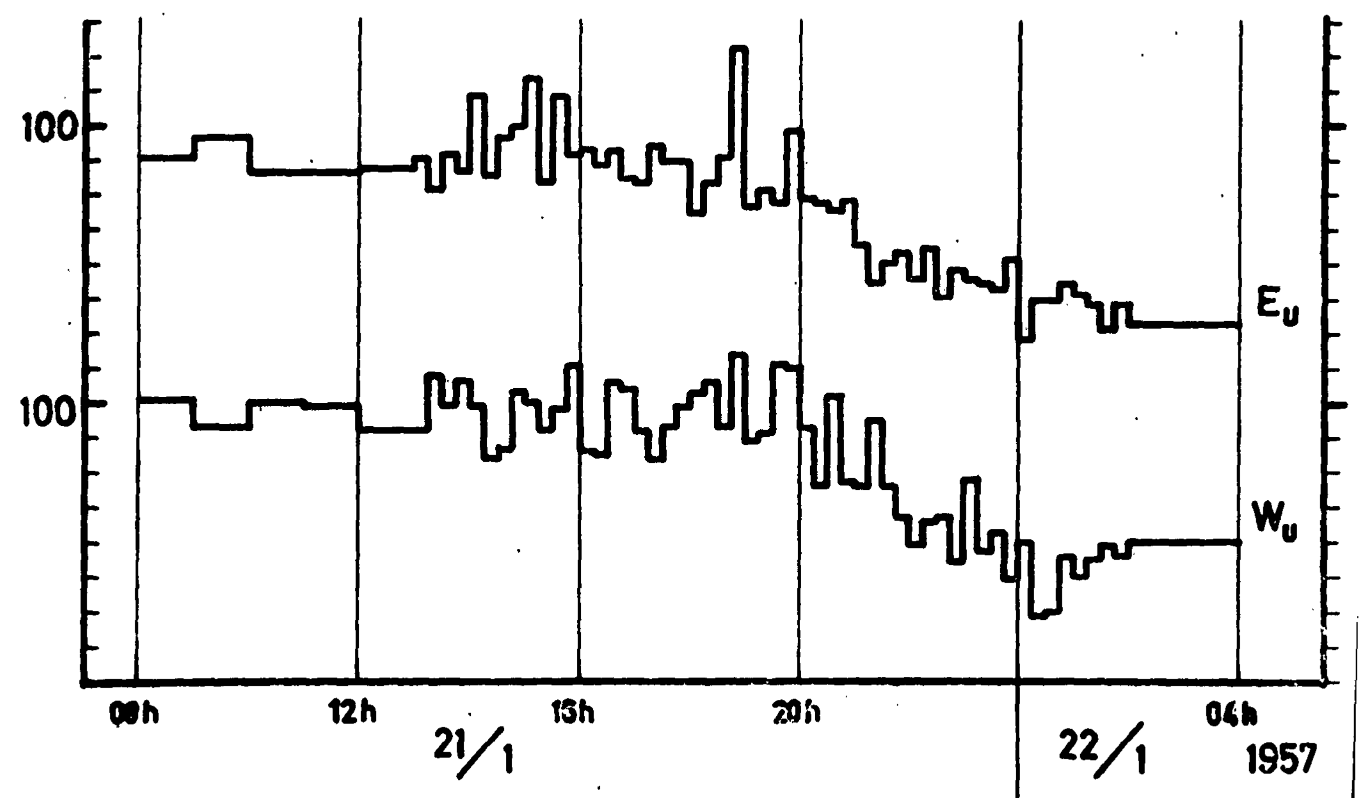
22/1
23/1
1957



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W_U
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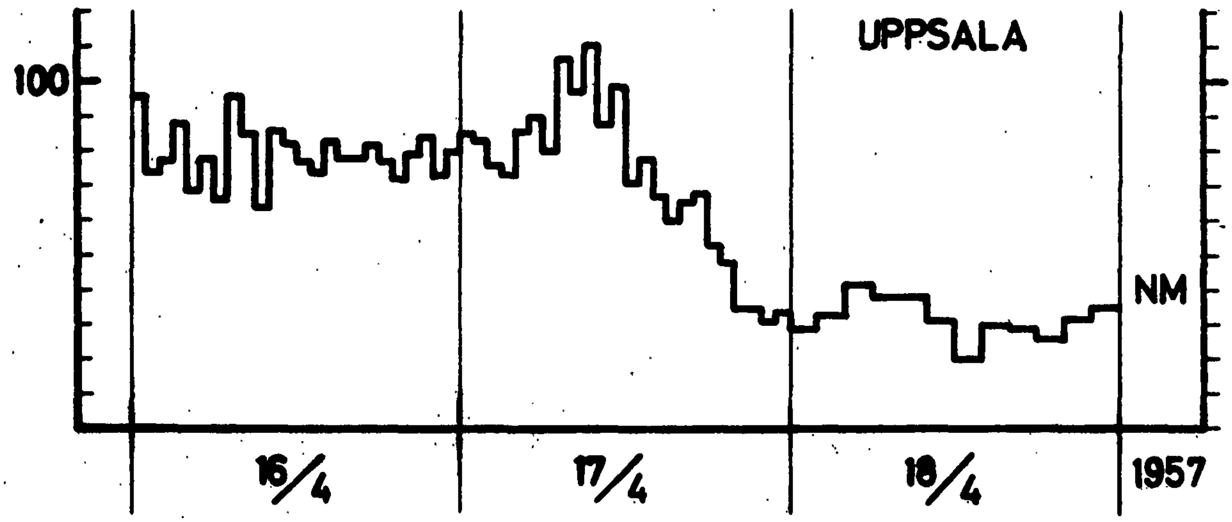
15h
20h
04h
21/1
22/1
1957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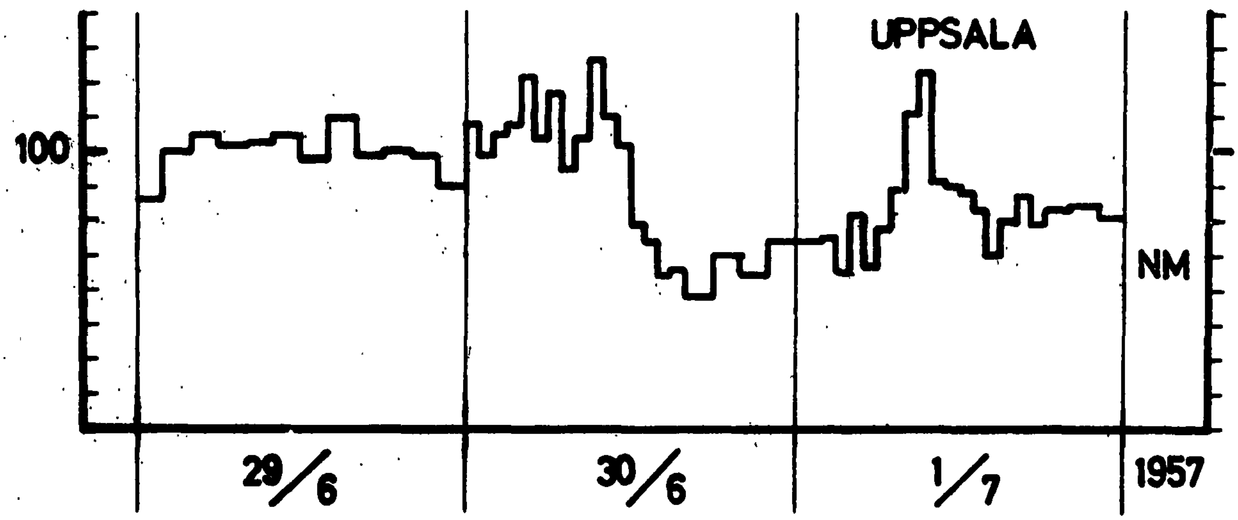
18/4
1957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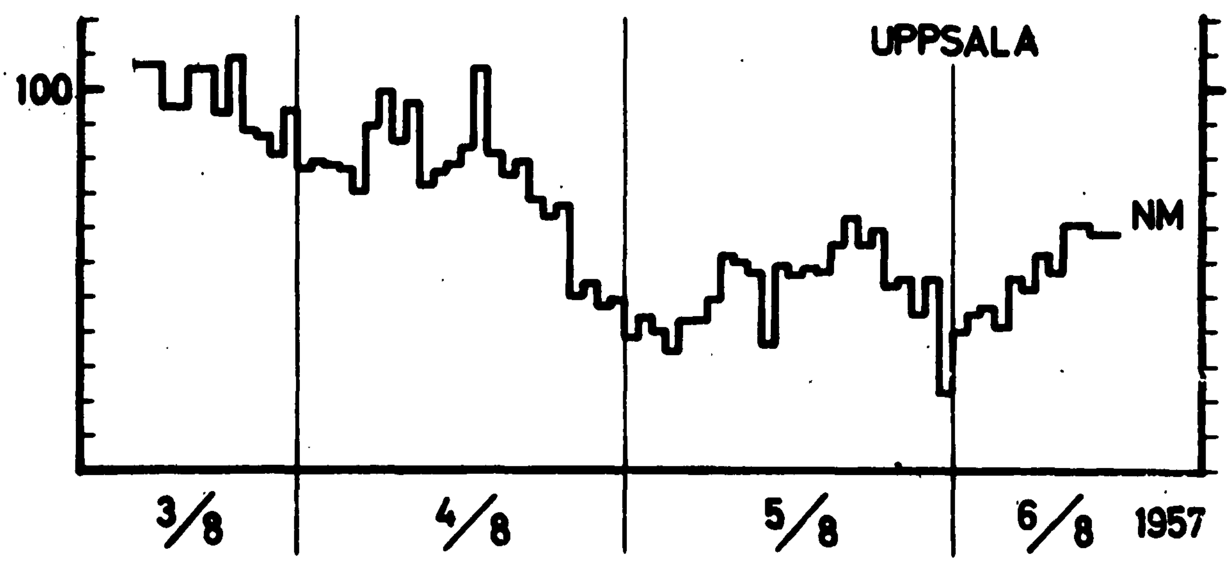
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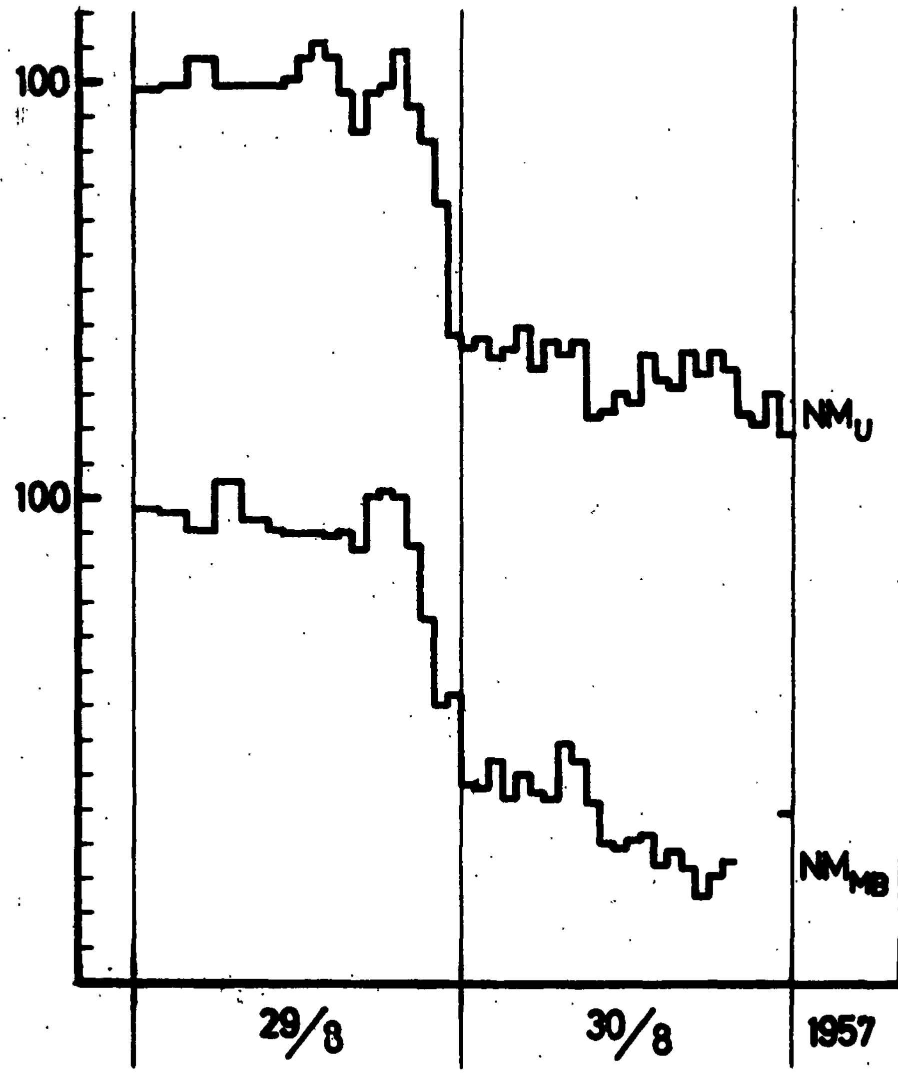
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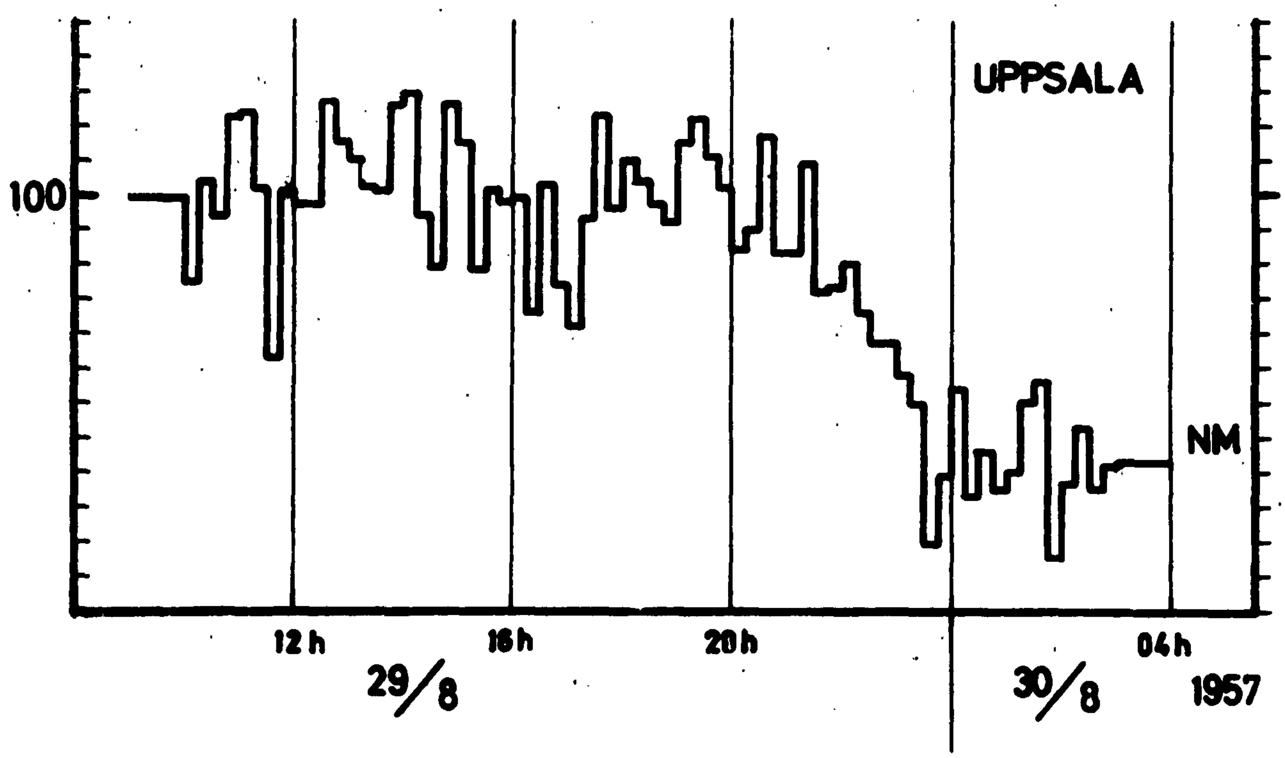
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04 h
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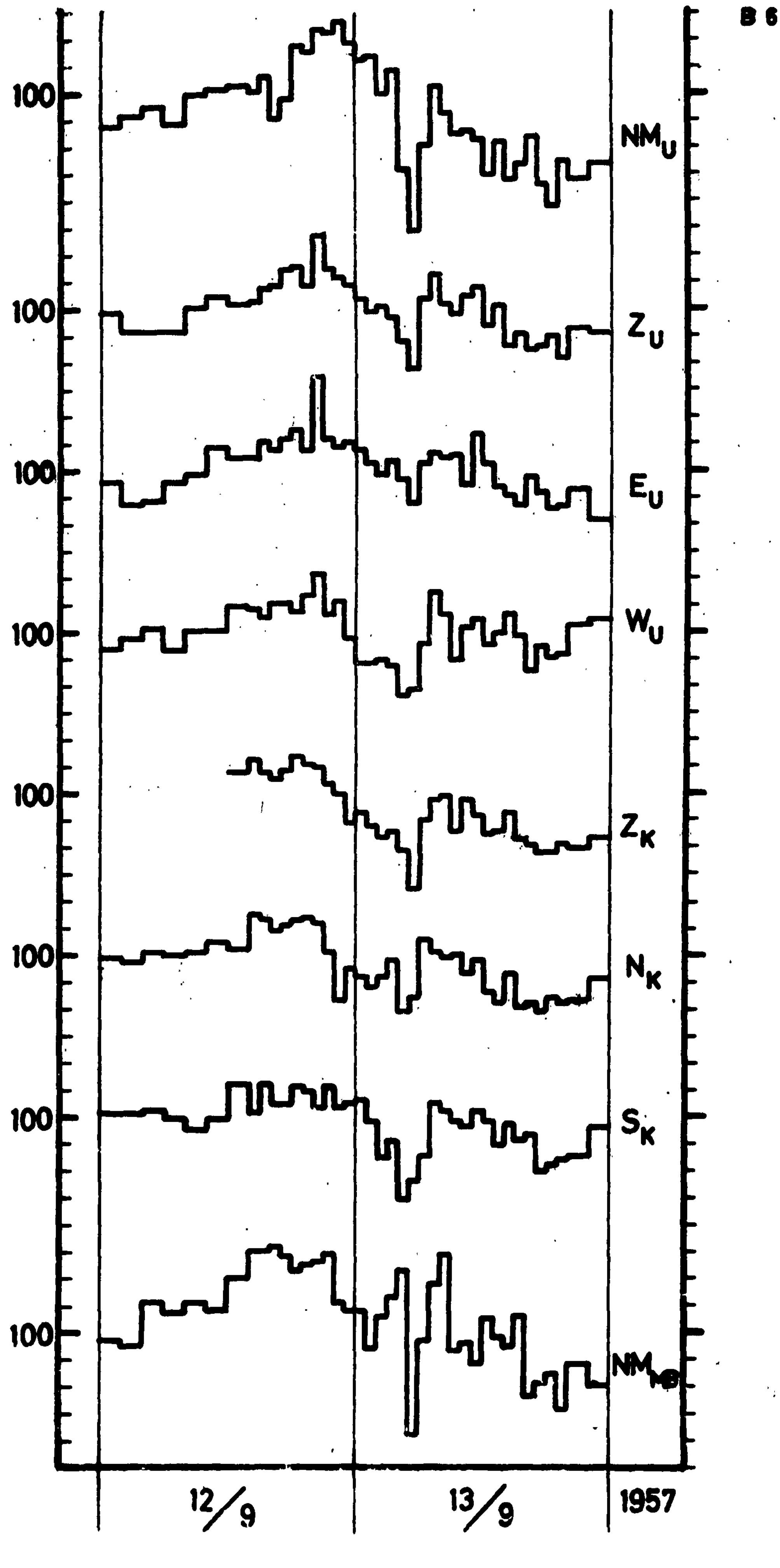

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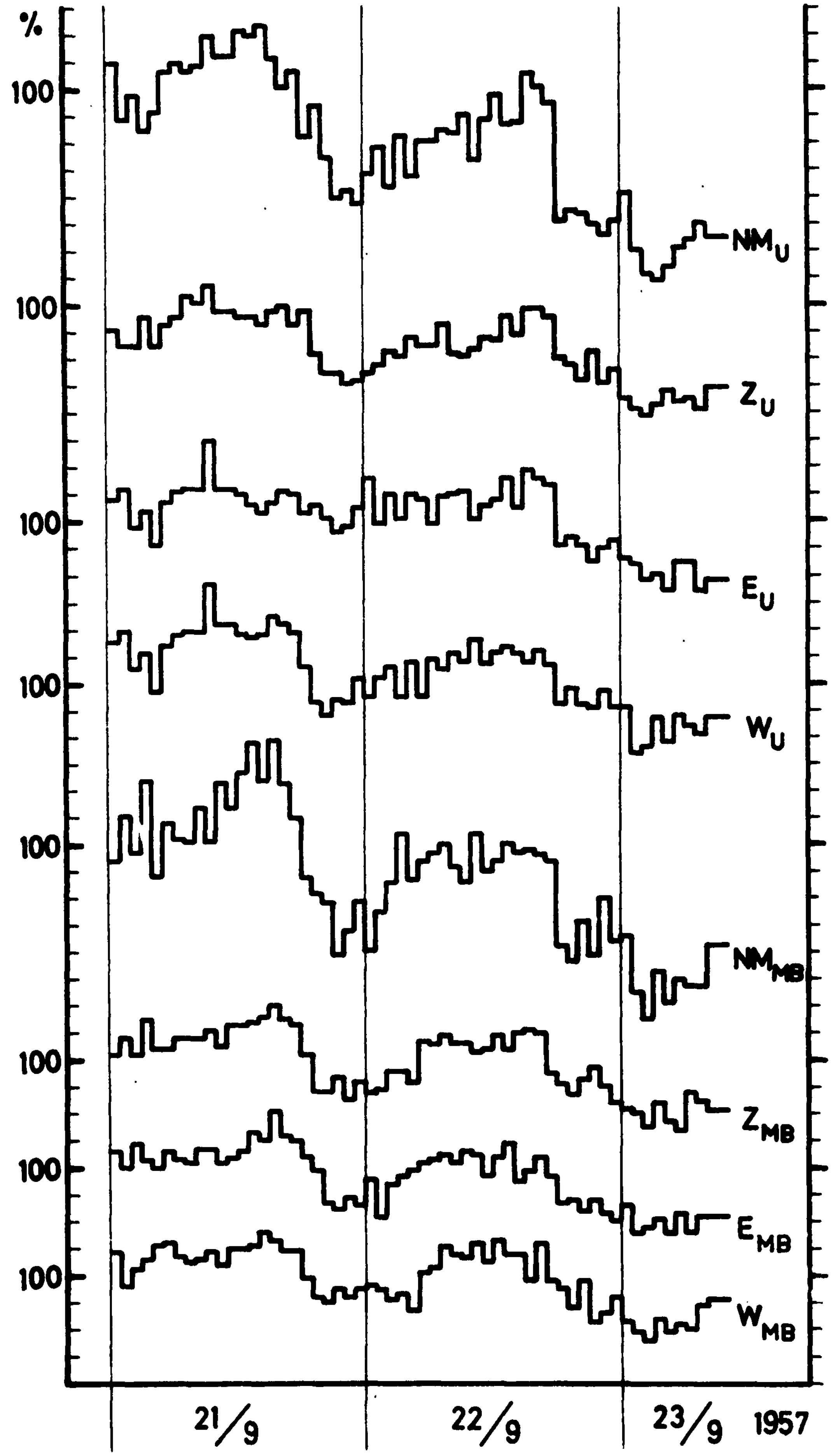
S_K
100
NM_MB
12/9
13/9
1957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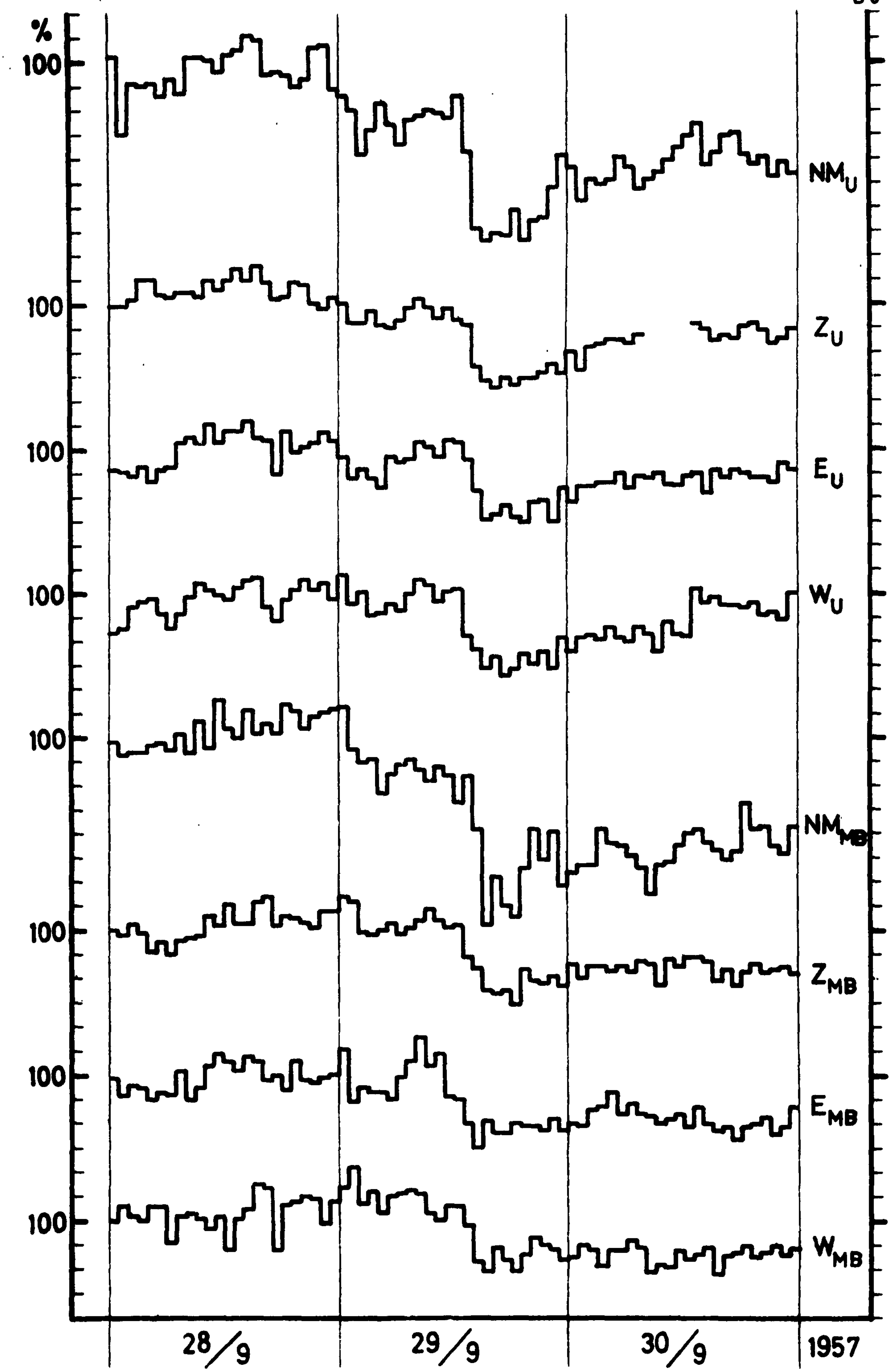
22/9
23/9
1957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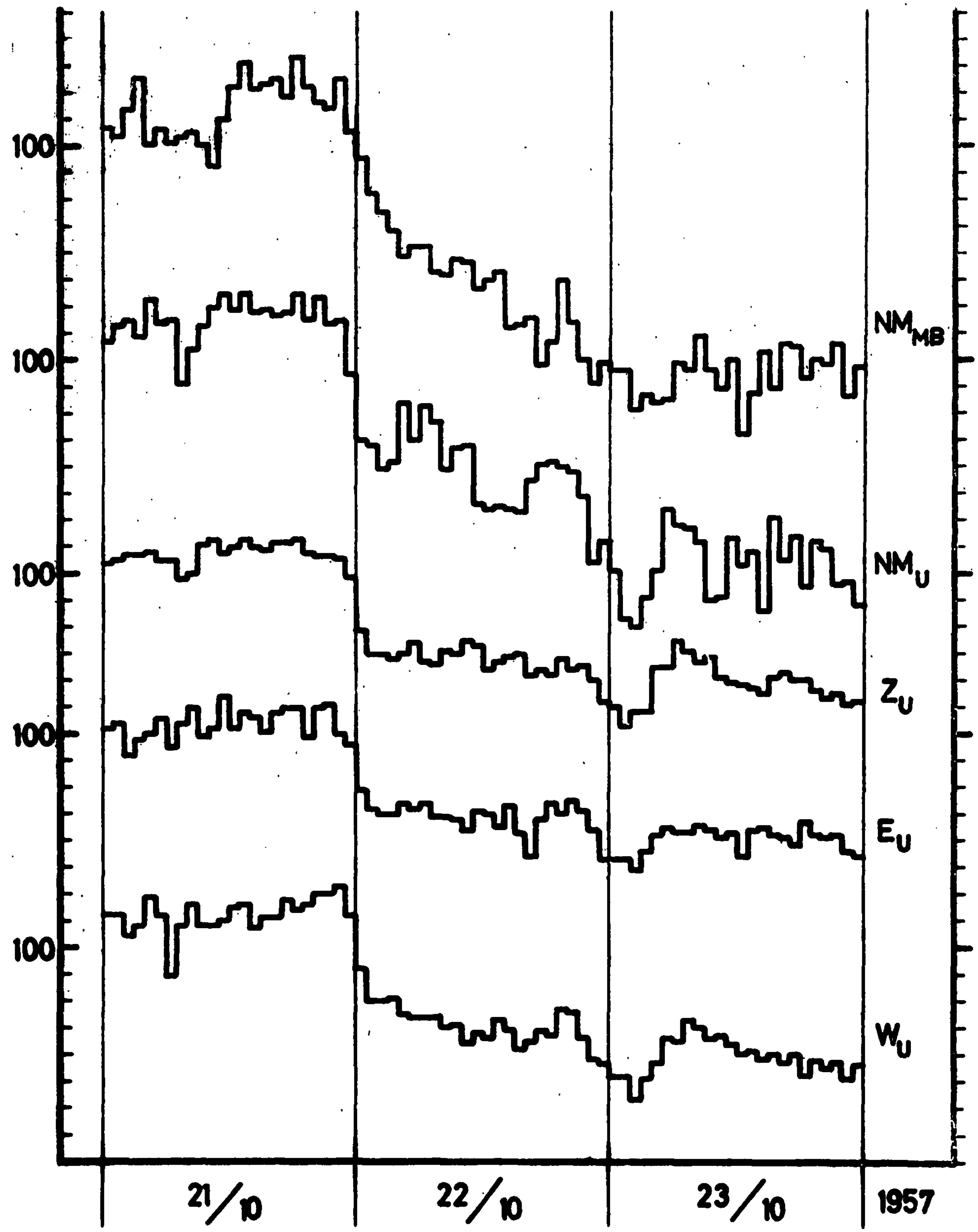
30/9
1957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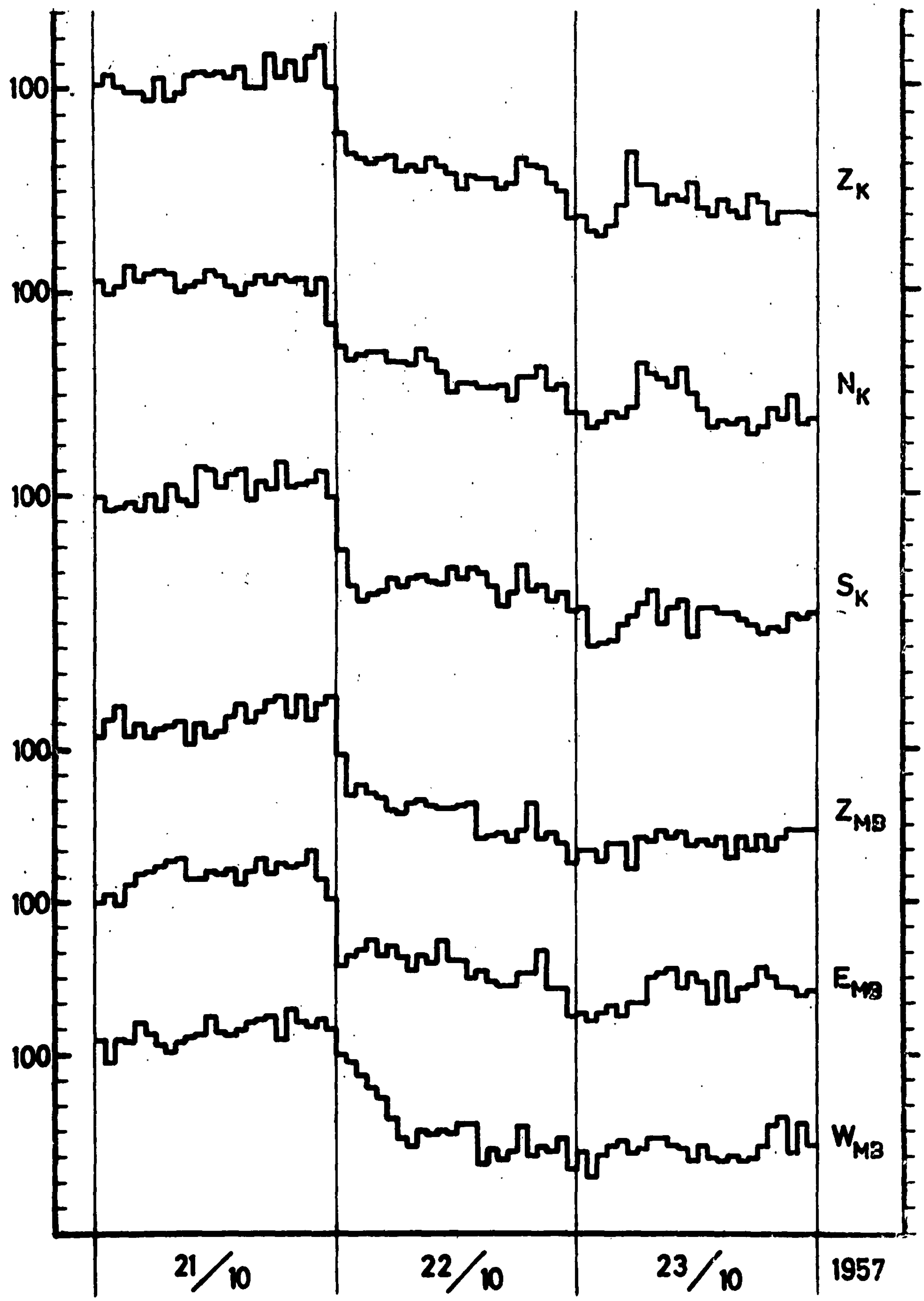
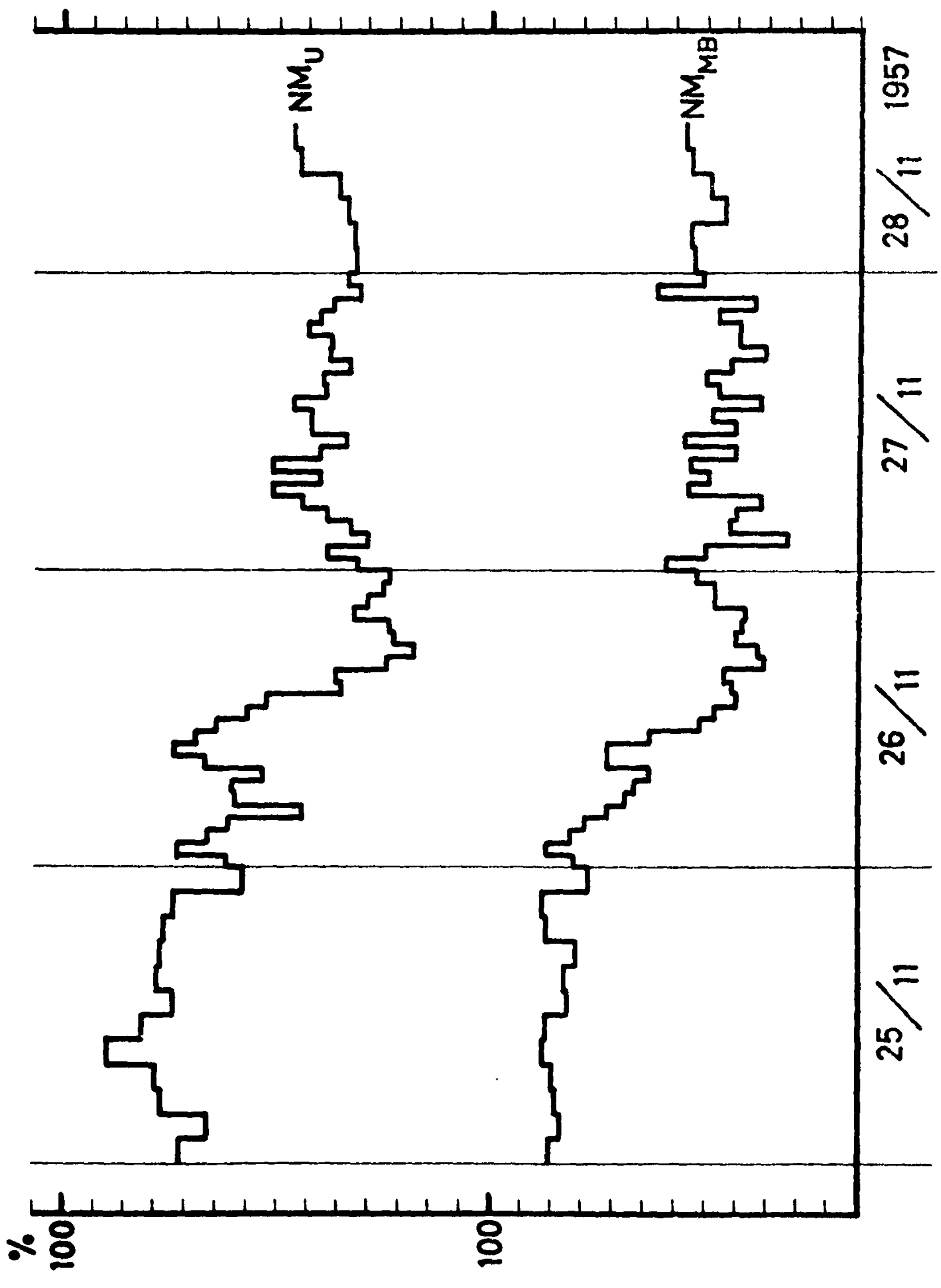
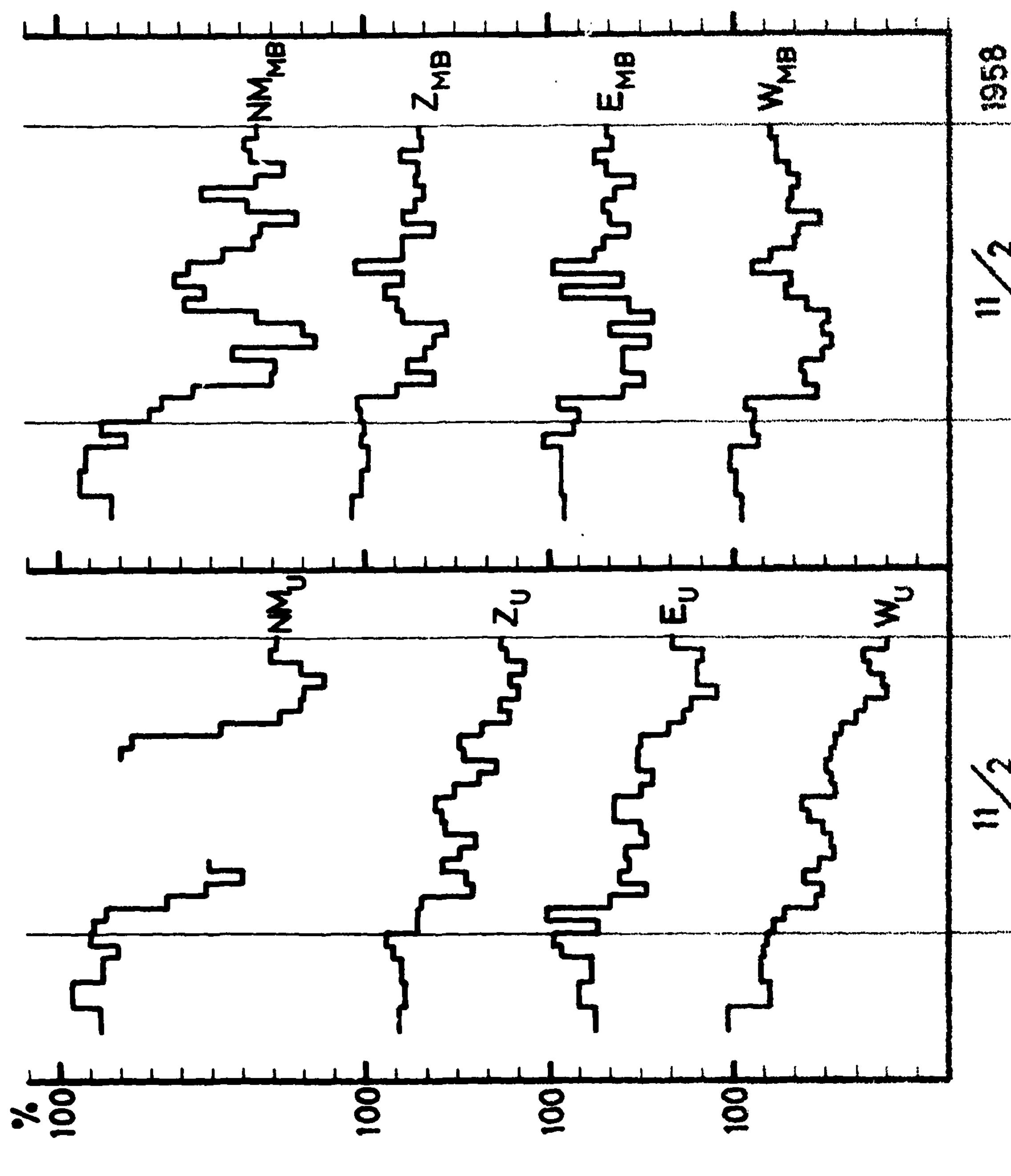
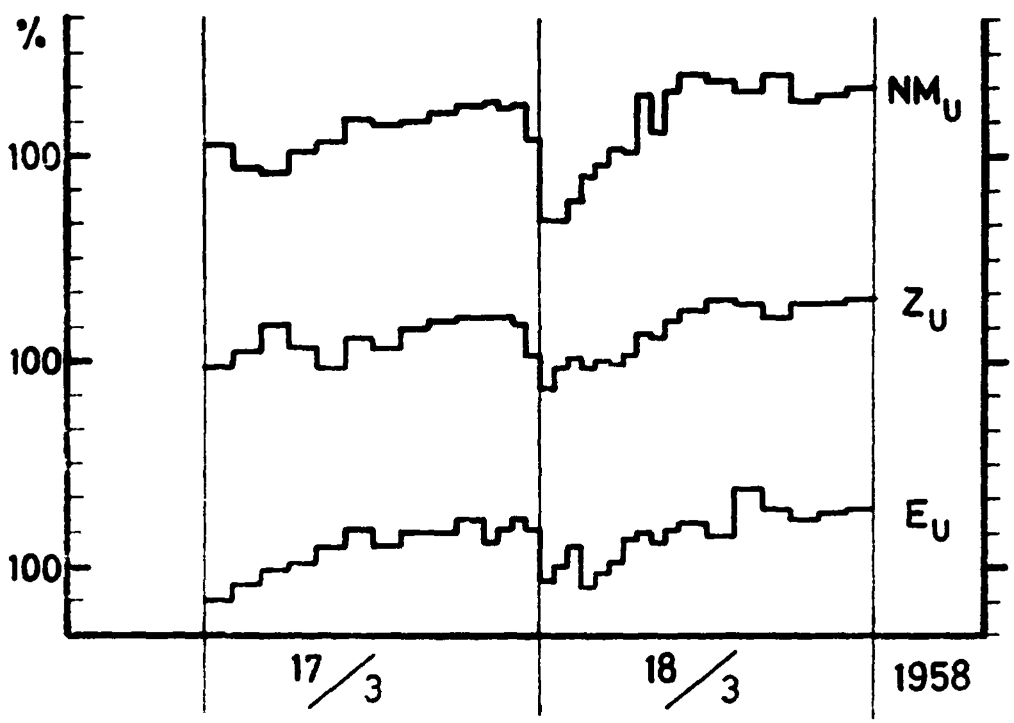
NM_MB
NM_U
Z_U
E_U
W_U
21/10
22/10
23/10
1957


100
100
100
100
100
100
Z_K
N_K
S_K
Z_{MB}
E_{MB}
W_{MB}
21/10
22/10
23/10
1957

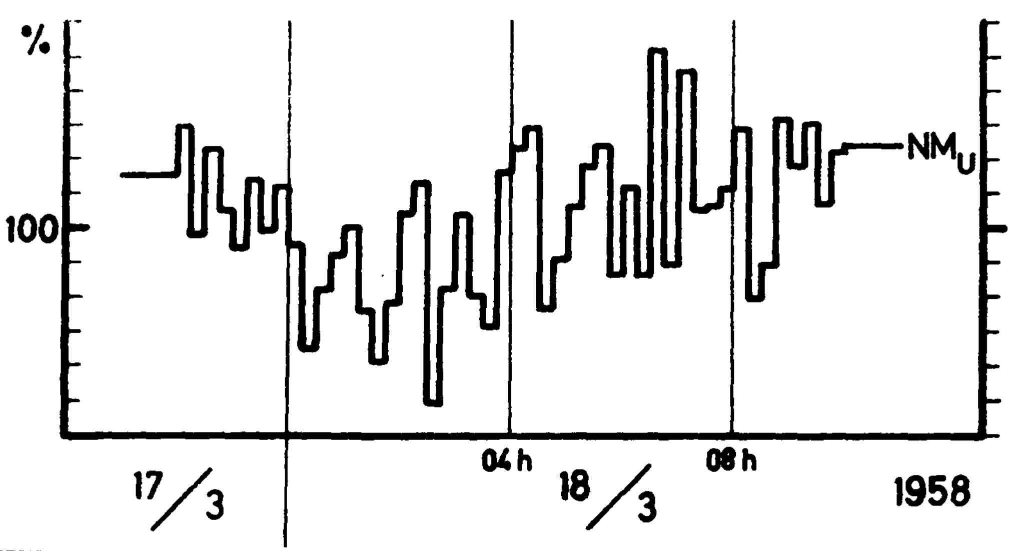

%
100
100
NM$_U$
NM$_{MB}$
25/11
26/11
27/11
28/11
1957



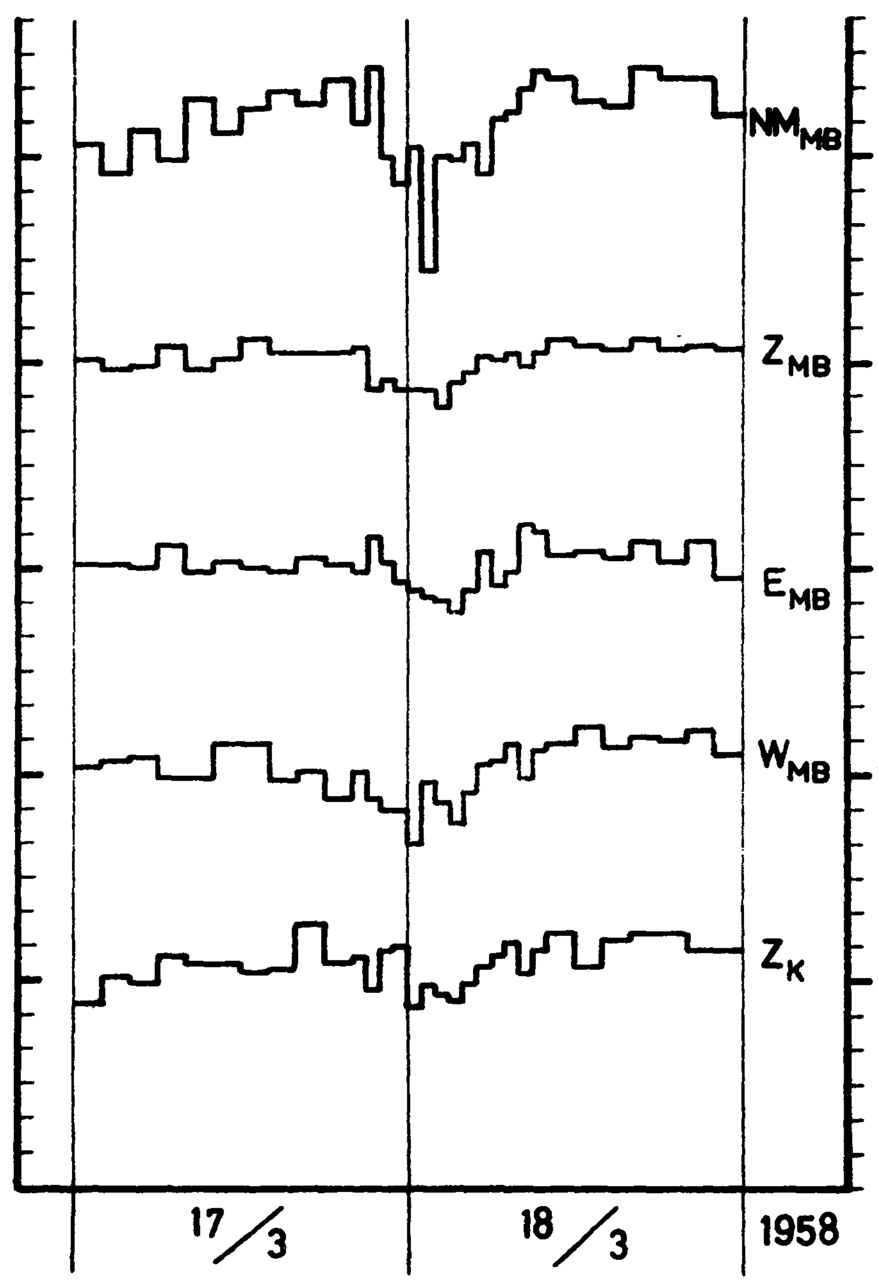
%
100
100
100
100
NM_U
Z_U
E_U
W_U
11/2
NM_MB
Z_MB
E_MB
W_MB
11/2
1958



%
100
100
100
NM_U
Z_U
E_U
17/3
18/3
1958

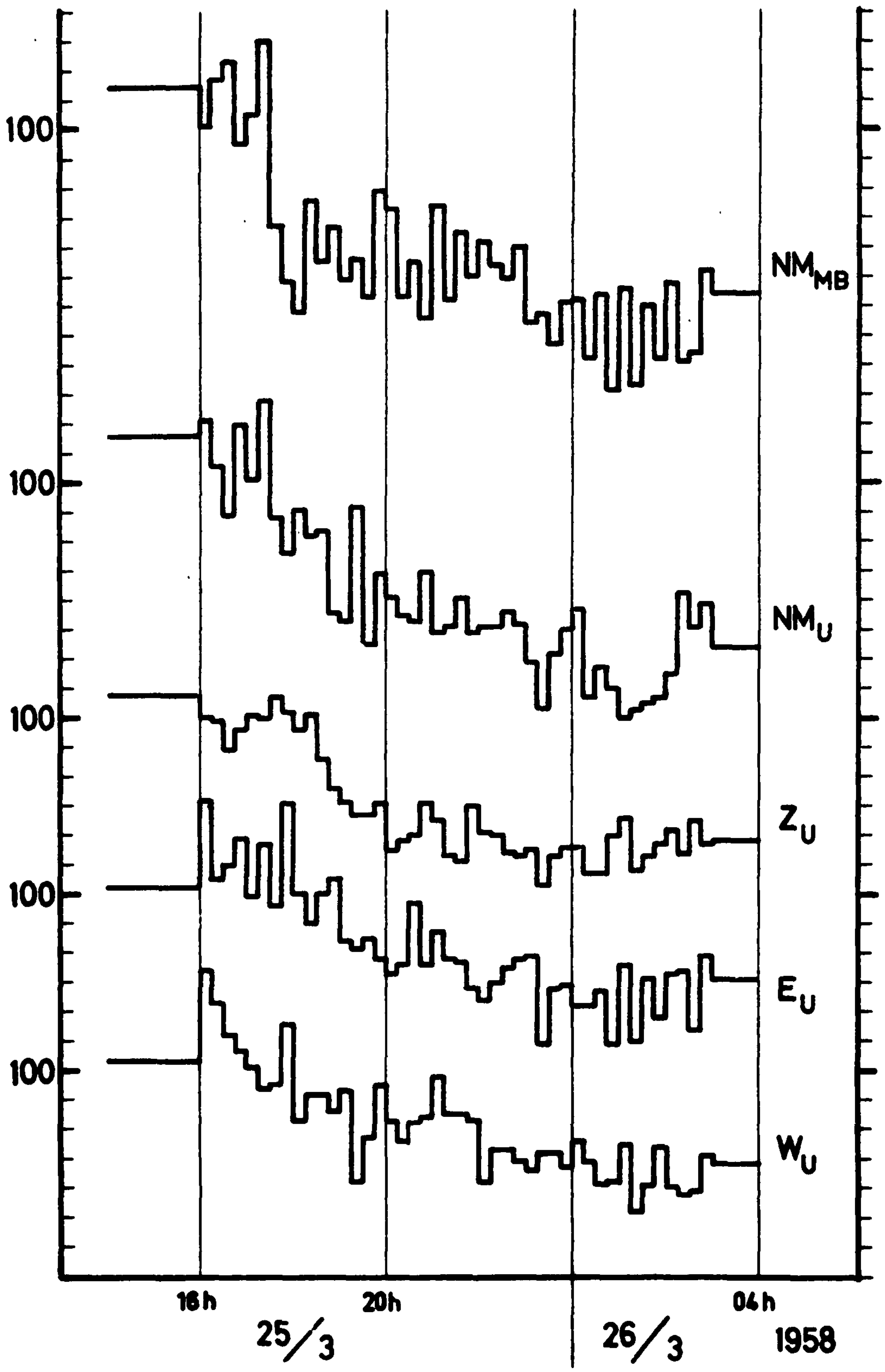


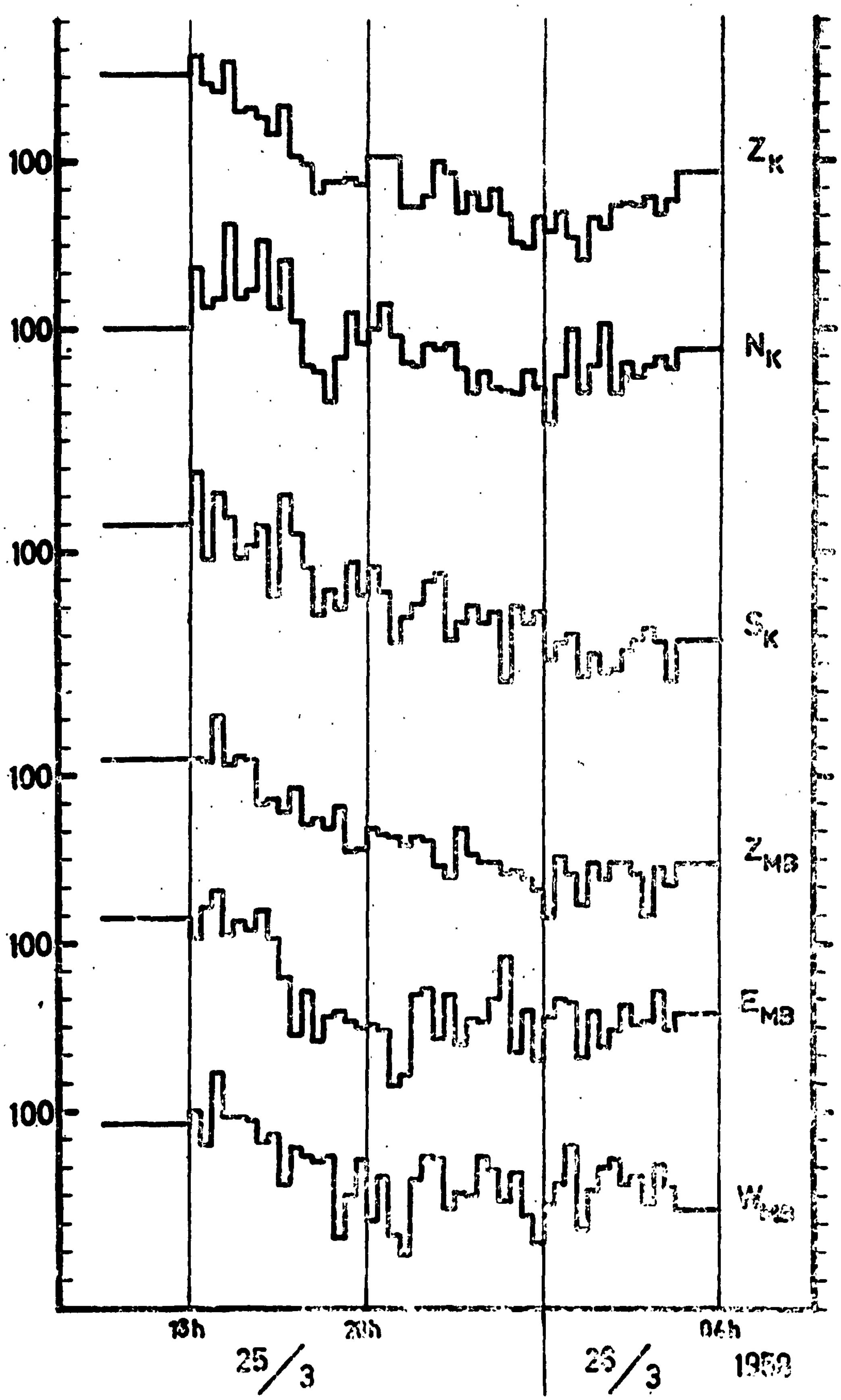
%
100
NM_U
17/3
04h
18/3
08h
1958

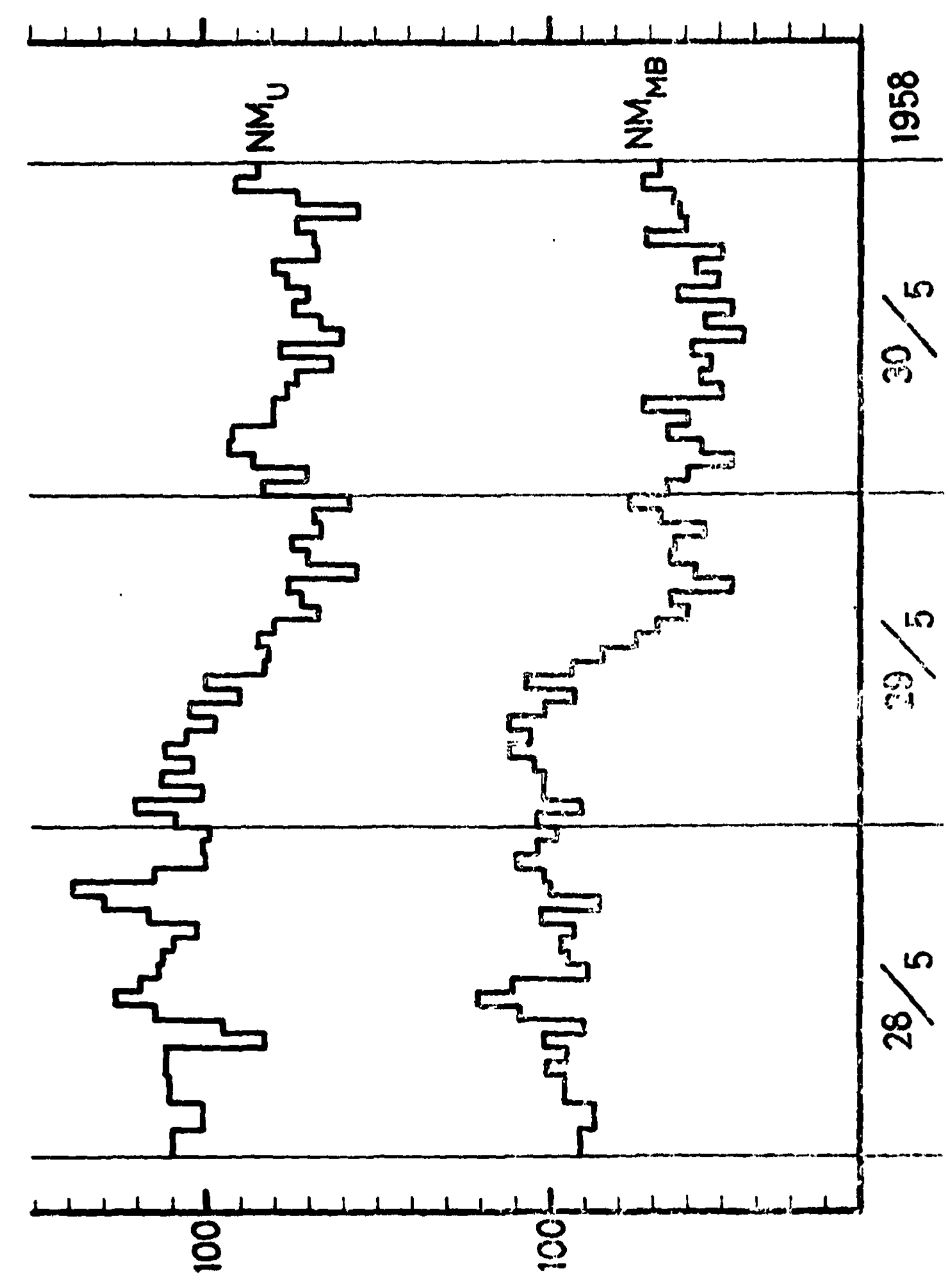


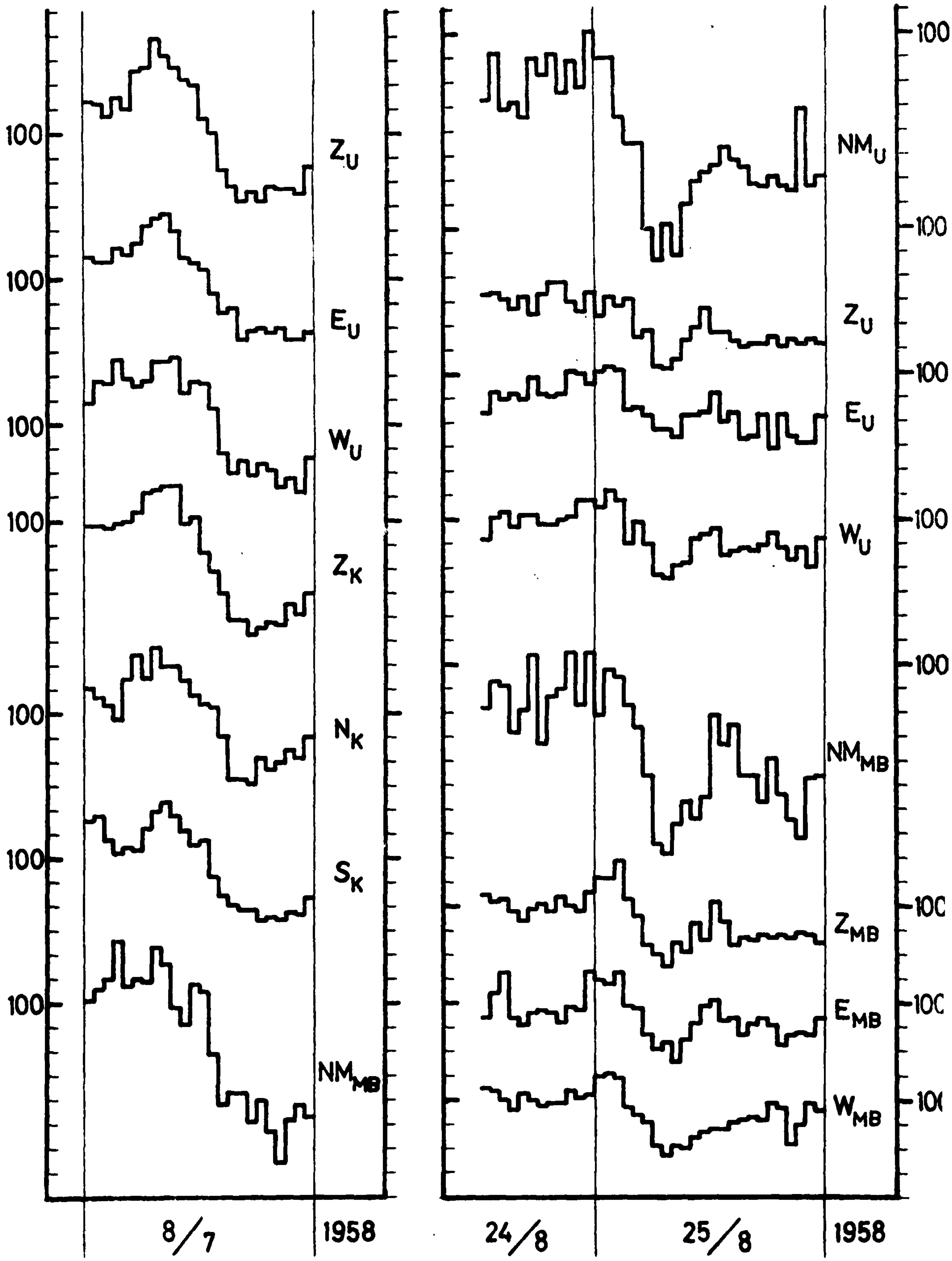
%
100
100
100
100
100
NM_MB
Z_MB
E_MB
W_MB
Z_K
17/3
18/3
1958

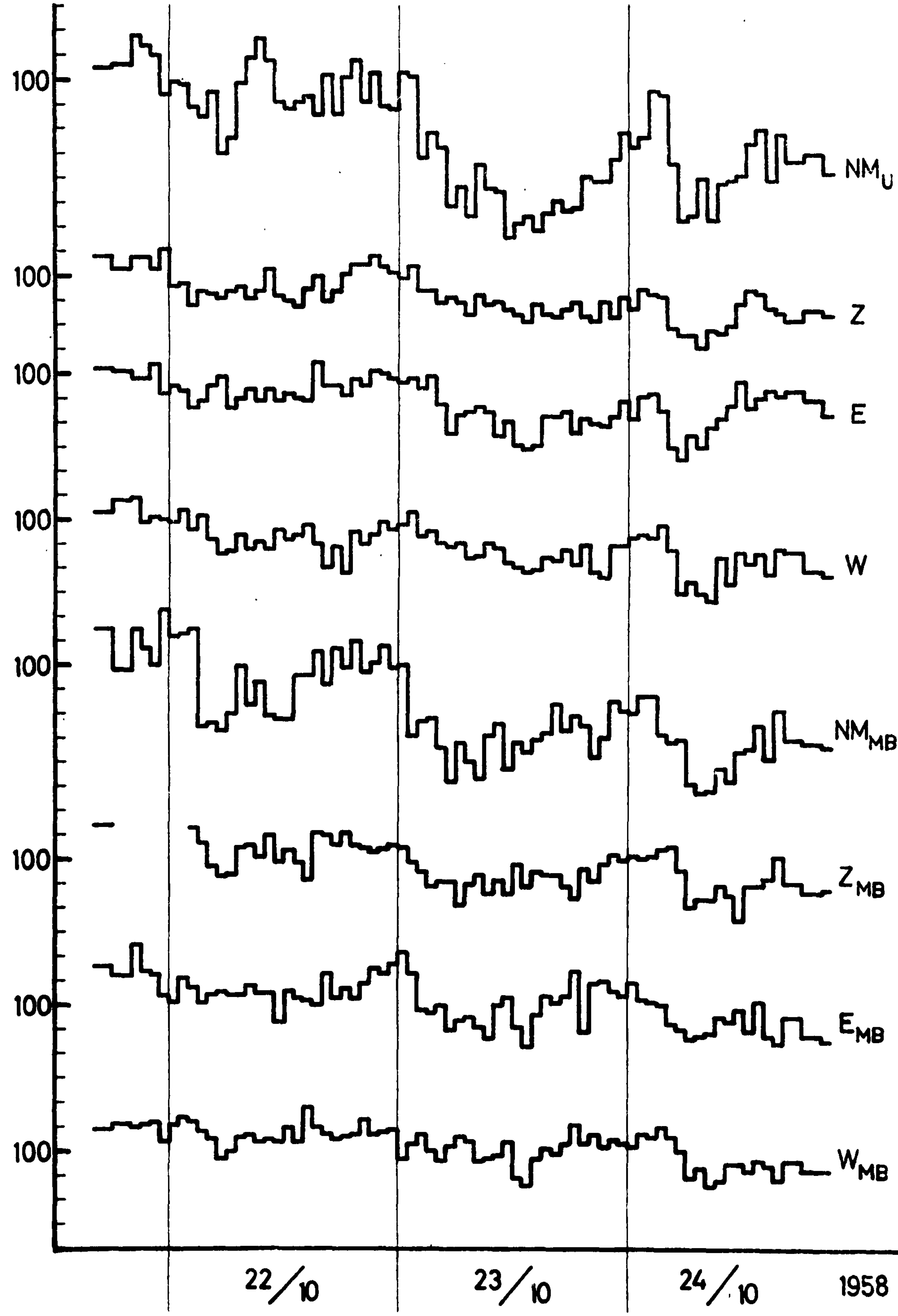
B 13

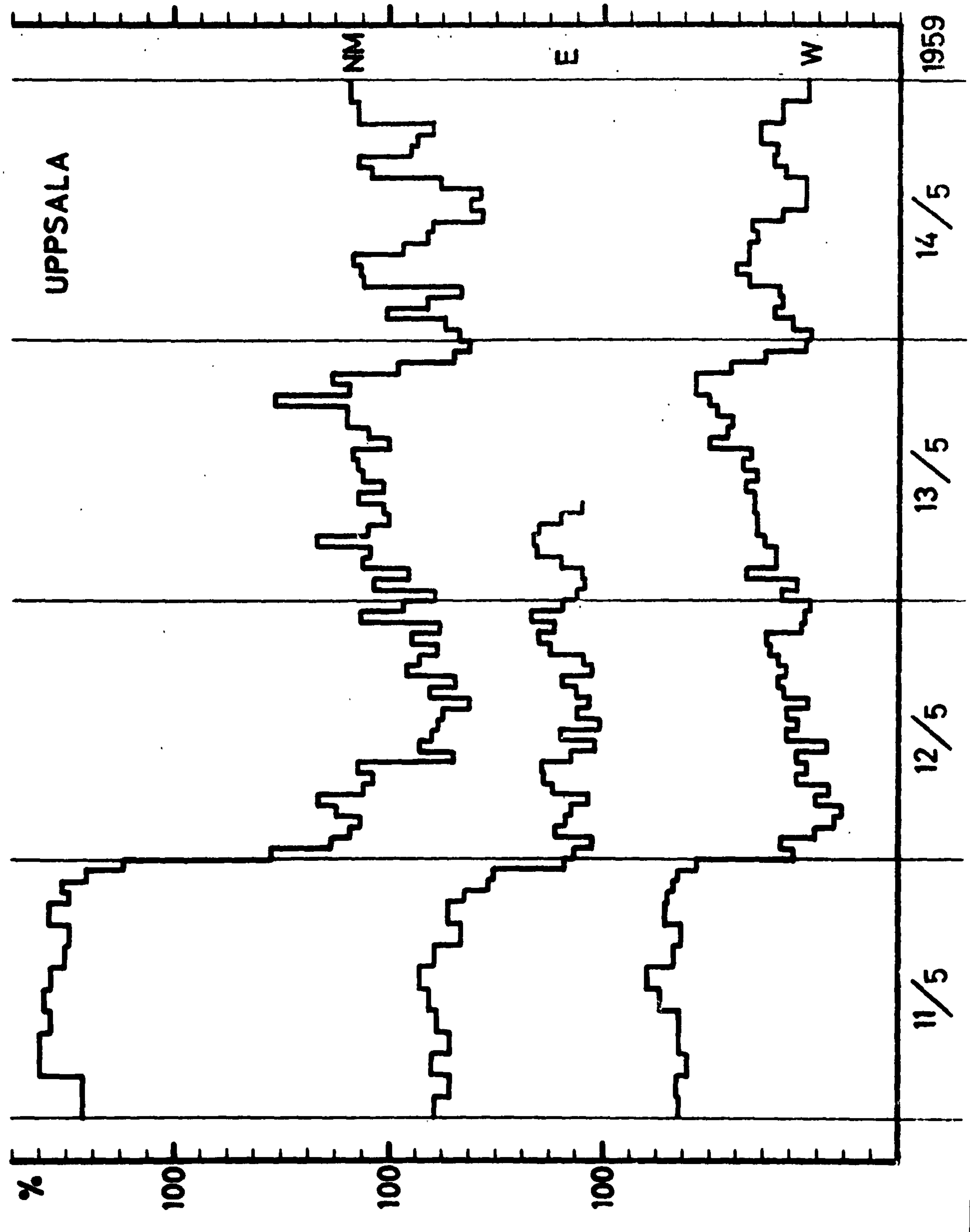

100
100
100
100
100
NM$_{MB}$
NM$_U$
Z$_U$
E$_U$
W$_U$
16h
20h
04h
25/3
26/3
1958

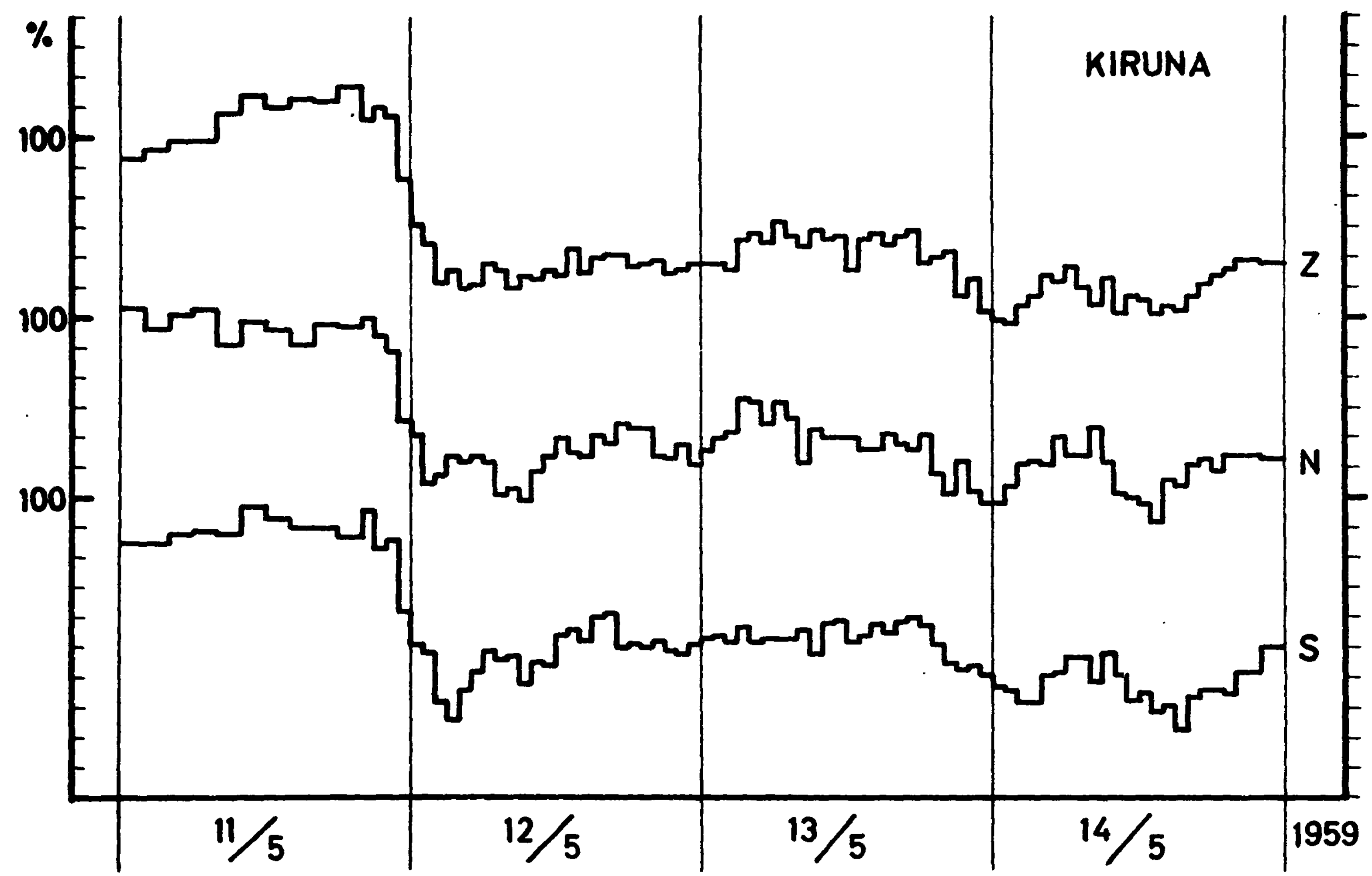

100
100
100
100
100
100
Z_K
N_K
S_K
Z_{MB}
E_{MB}
W_{MB}
18h
20h
04h
25/3
26/3
1959

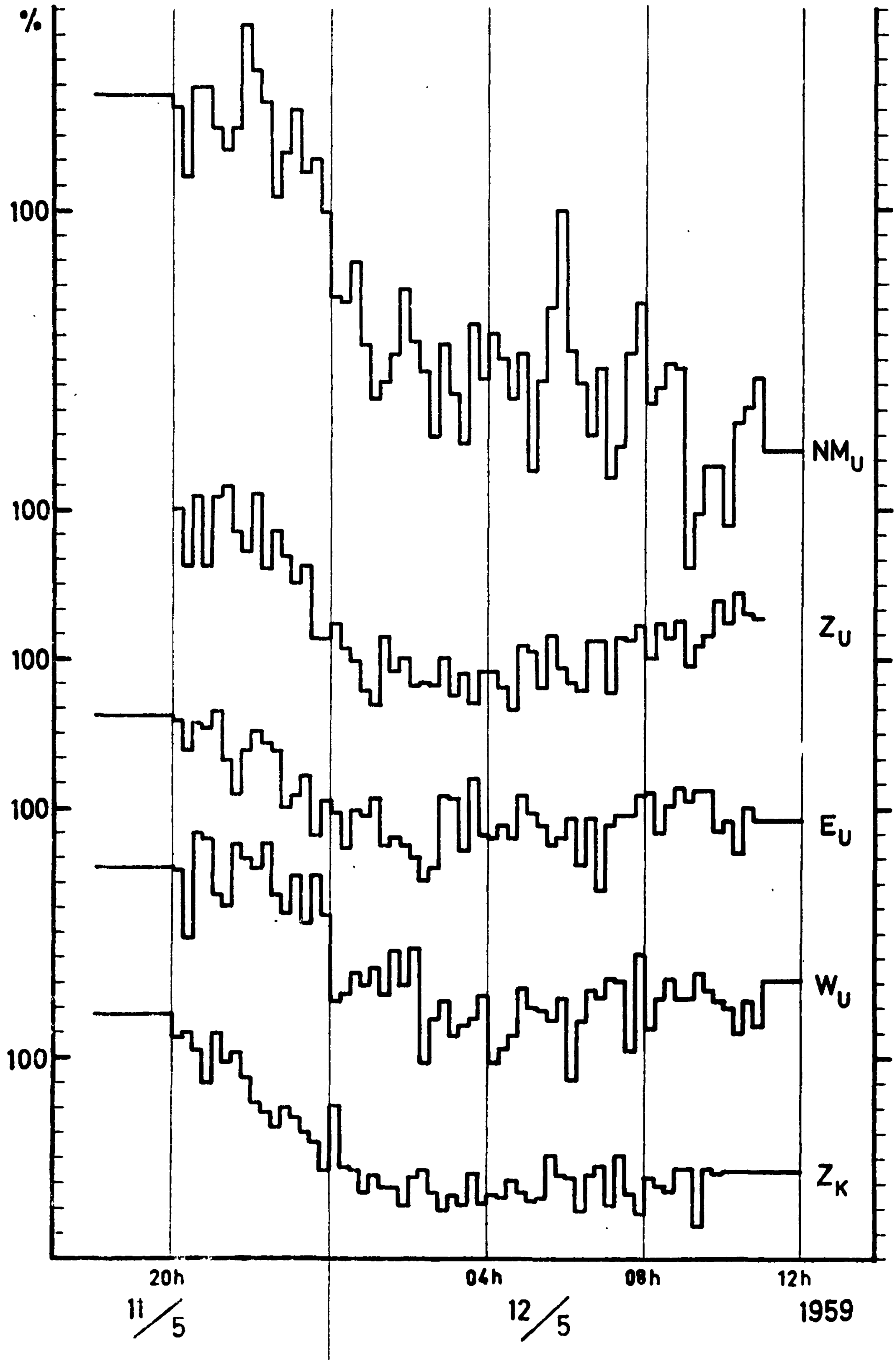

100
100
NMU
NMMB
1958
28/5
29/5
30/5

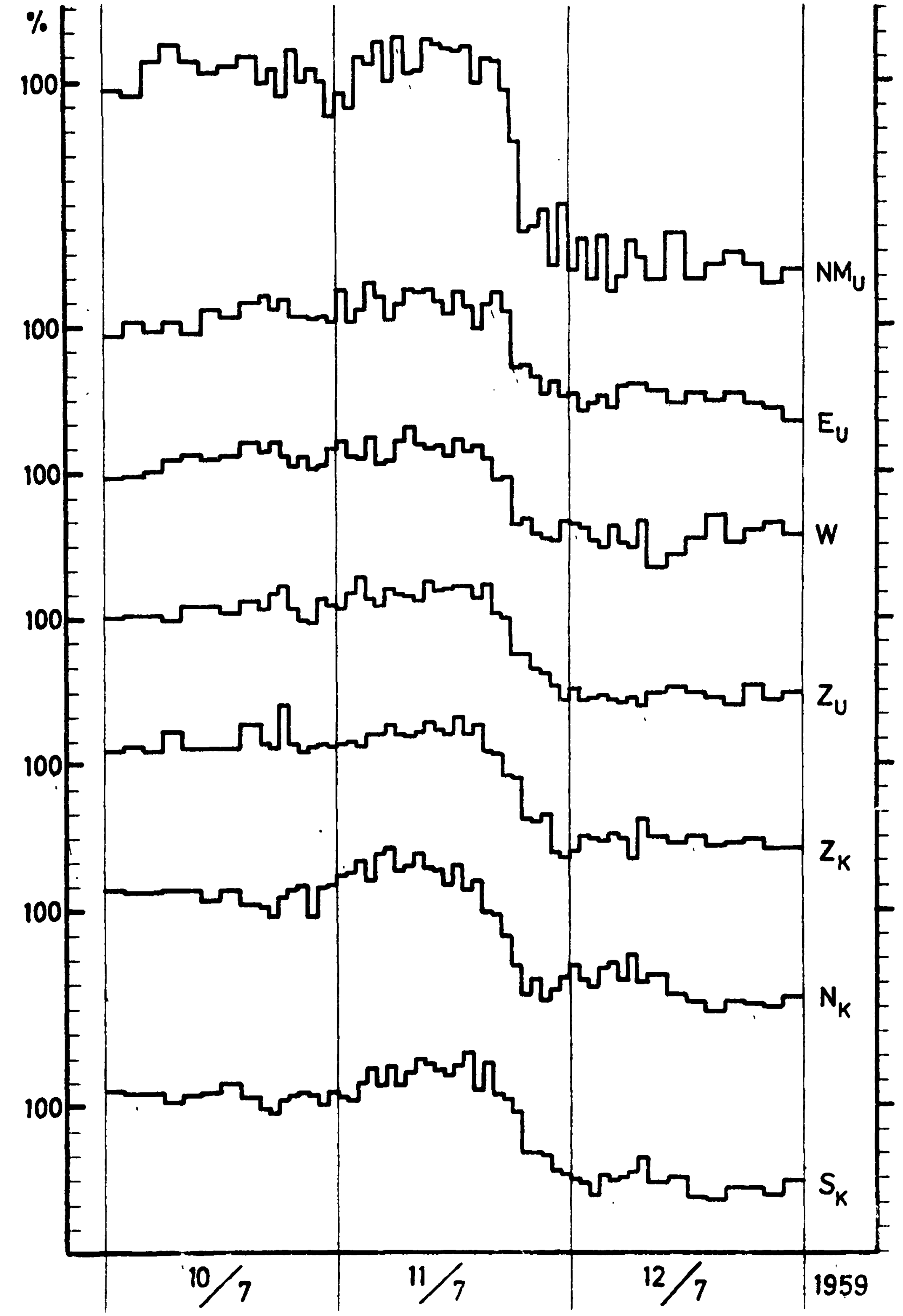

100
100
100
100
100
100
100
Z_U
E_U
W_U
Z_K
N_K
S_K
NM_{MB}
8/7
1958
100
100
100
100
100
100
100
100
NM_U
Z_U
E_U
W_U
NM_{MB}
Z_{MB}
E_{MB}
W_{MB}
24/8
25/8
1958

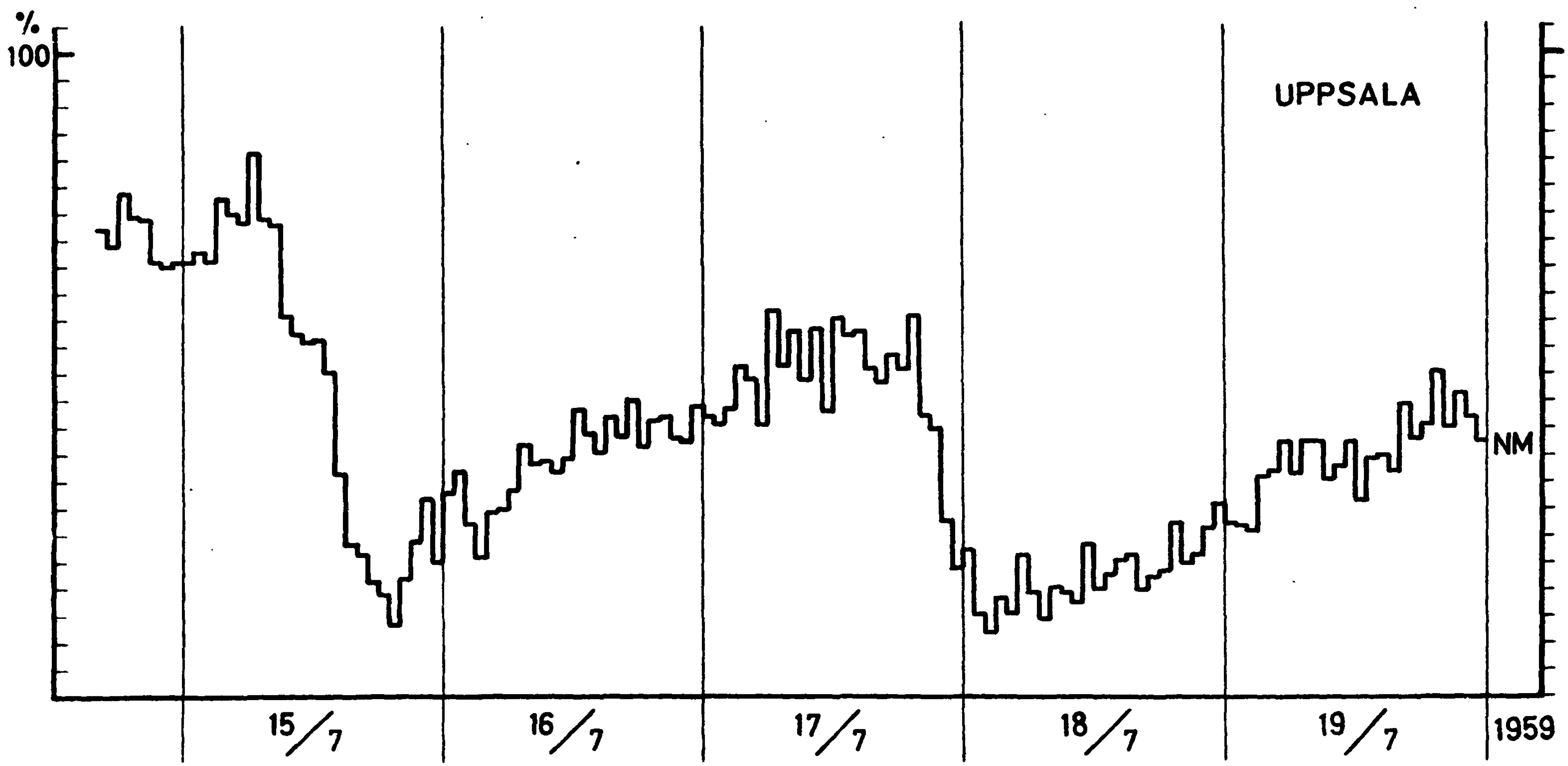

100
100
100
100
100
100
100
100
NM_U
Z
E
W
NM_{MB}
Z_{MB}
E_{MB}
W_{MB}
22/10
23/10
24/10
1958


UPPSALA
NM
E
W
1959
11/5
12/5
13/5
14/5
%
100
100
100

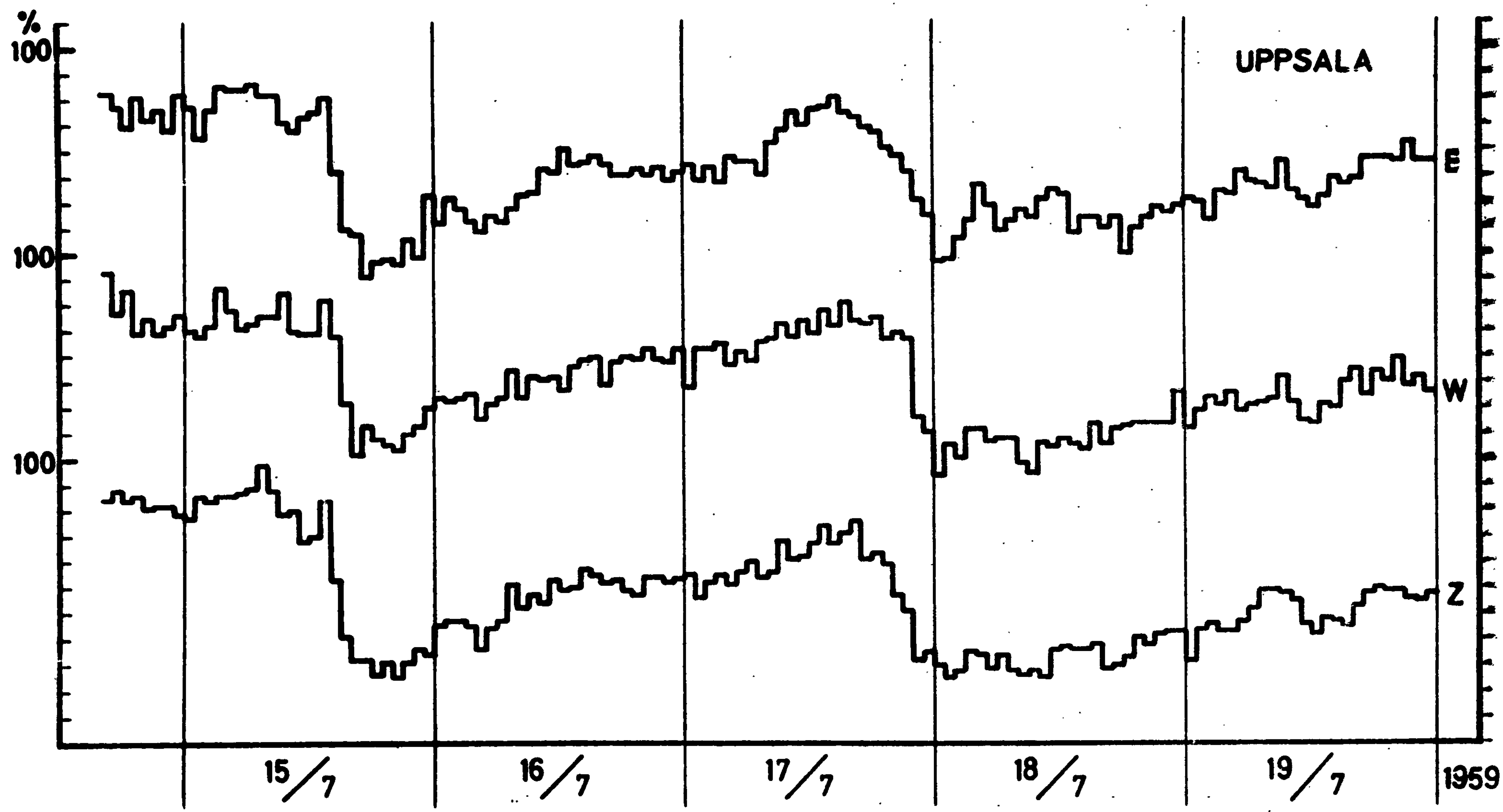

KIRUNA
%
100
100
100
Z
N
S
11/5
12/5
13/5
14/5
1959


%
100
100
100
100
100
NMU
ZU
EU
WU
ZK
20h
04h
08h
12h
11/5
12/5
1959

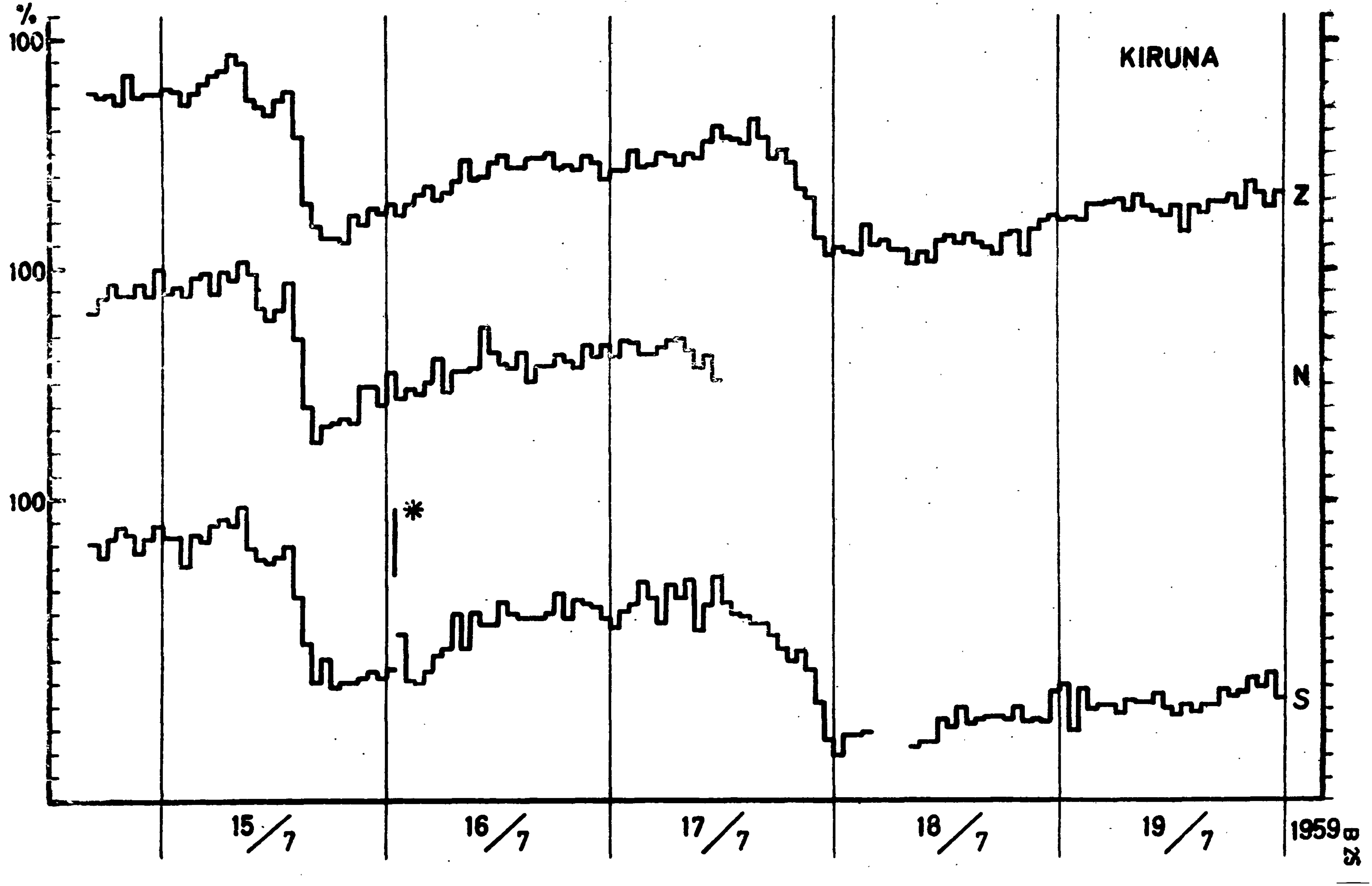

%
100
100
100
100
100
100
100
NMU
EU
W
ZU
ZK
NK
SK
10/7
11/7
12/7
1959

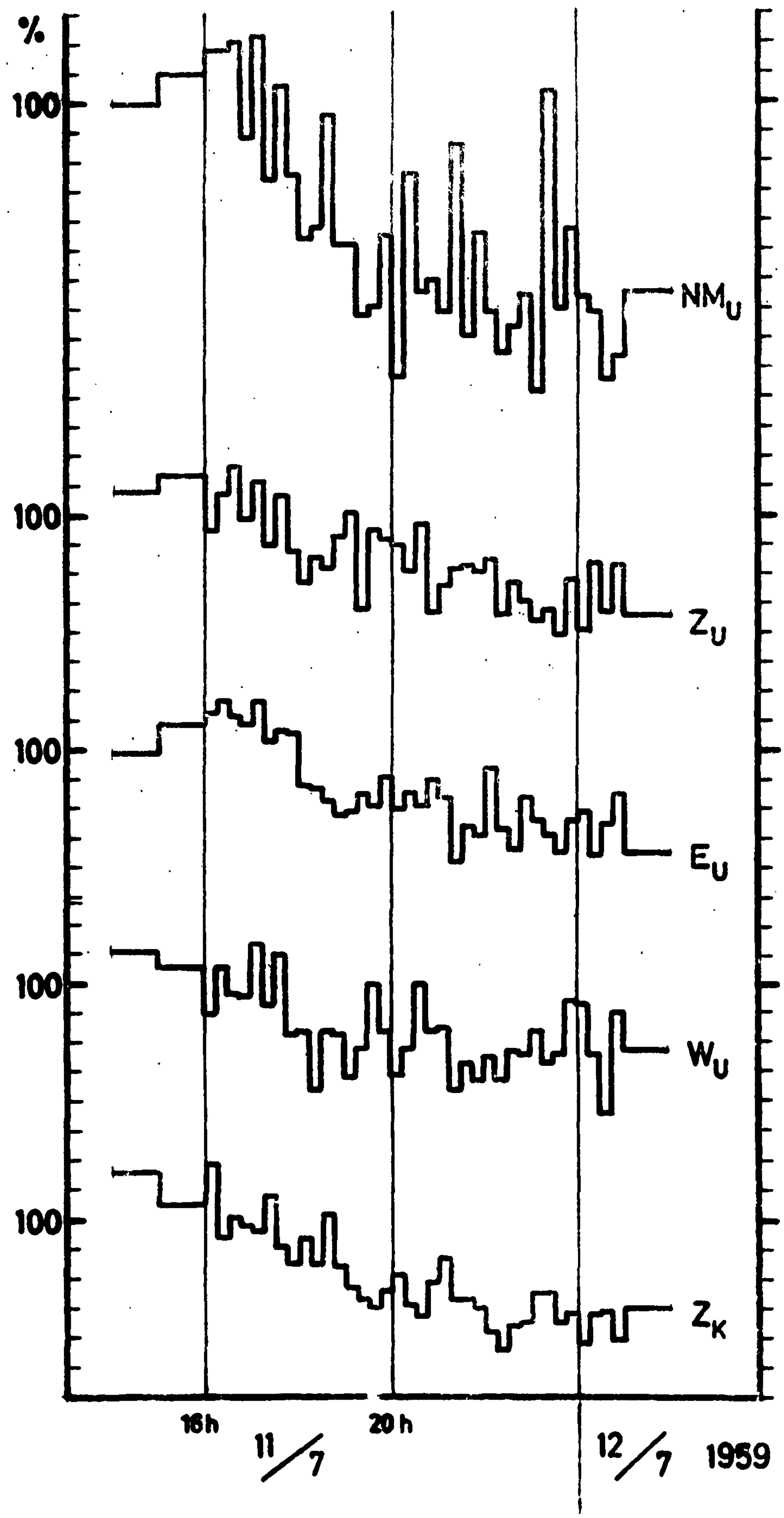


B 23

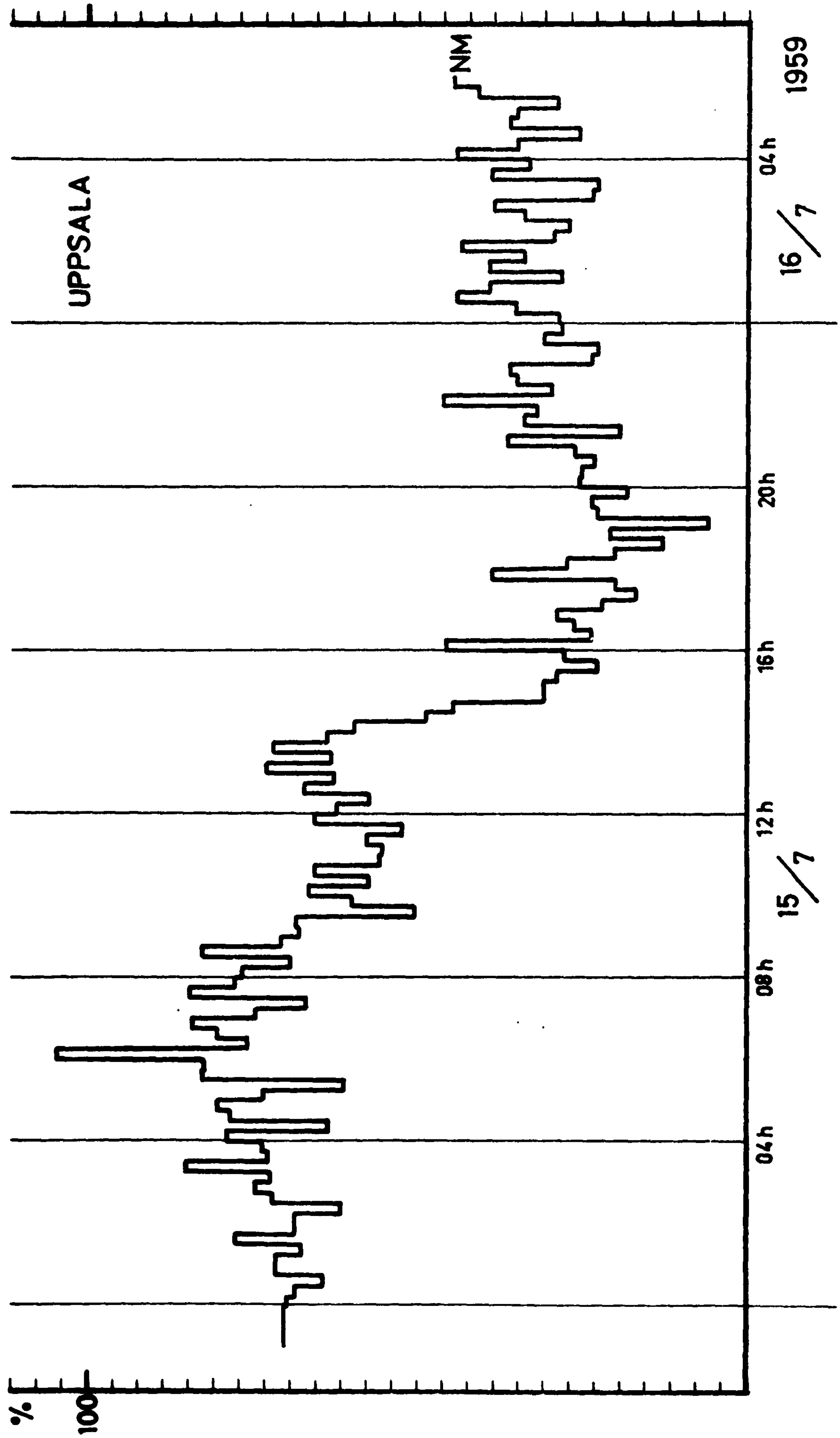


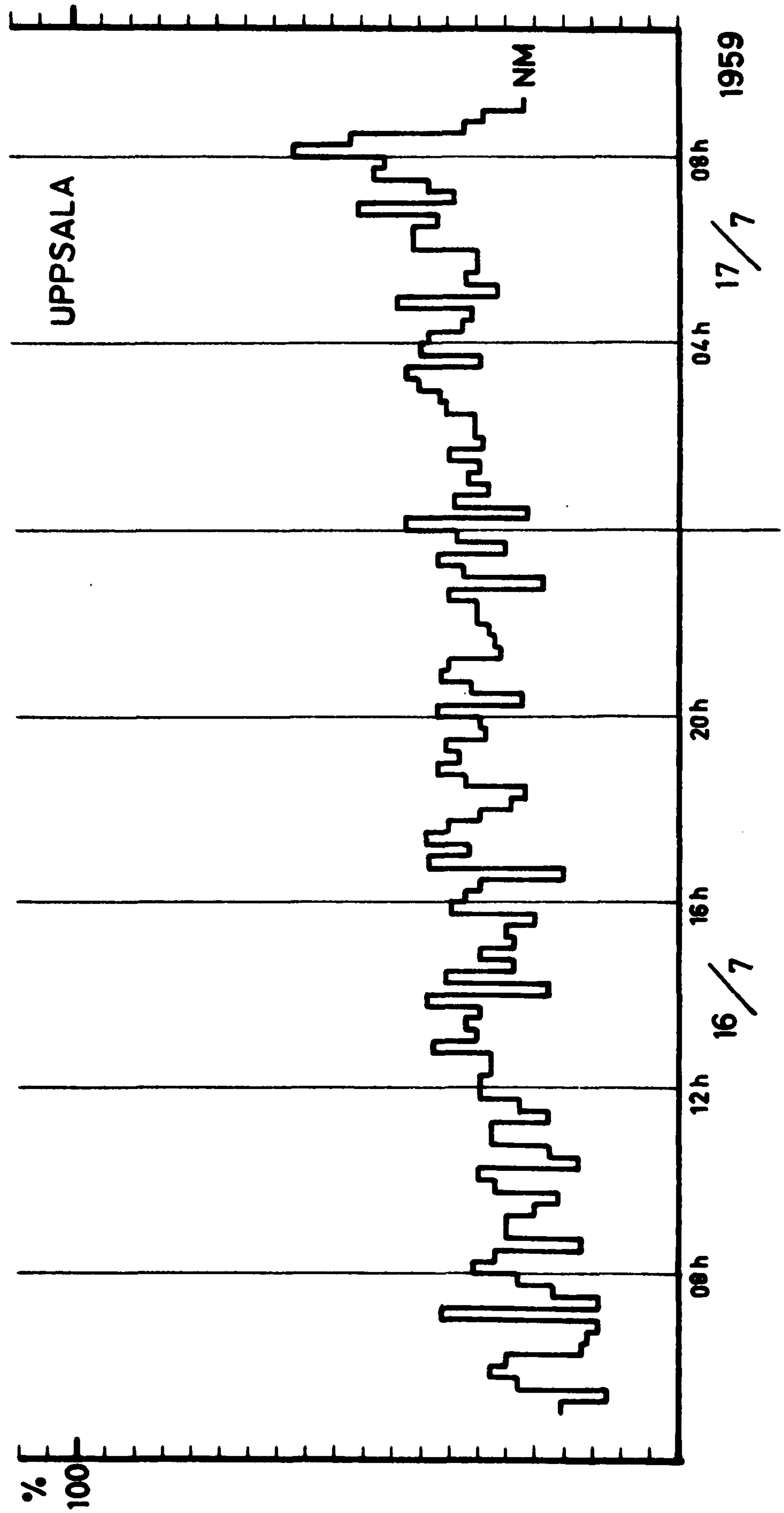
B 24

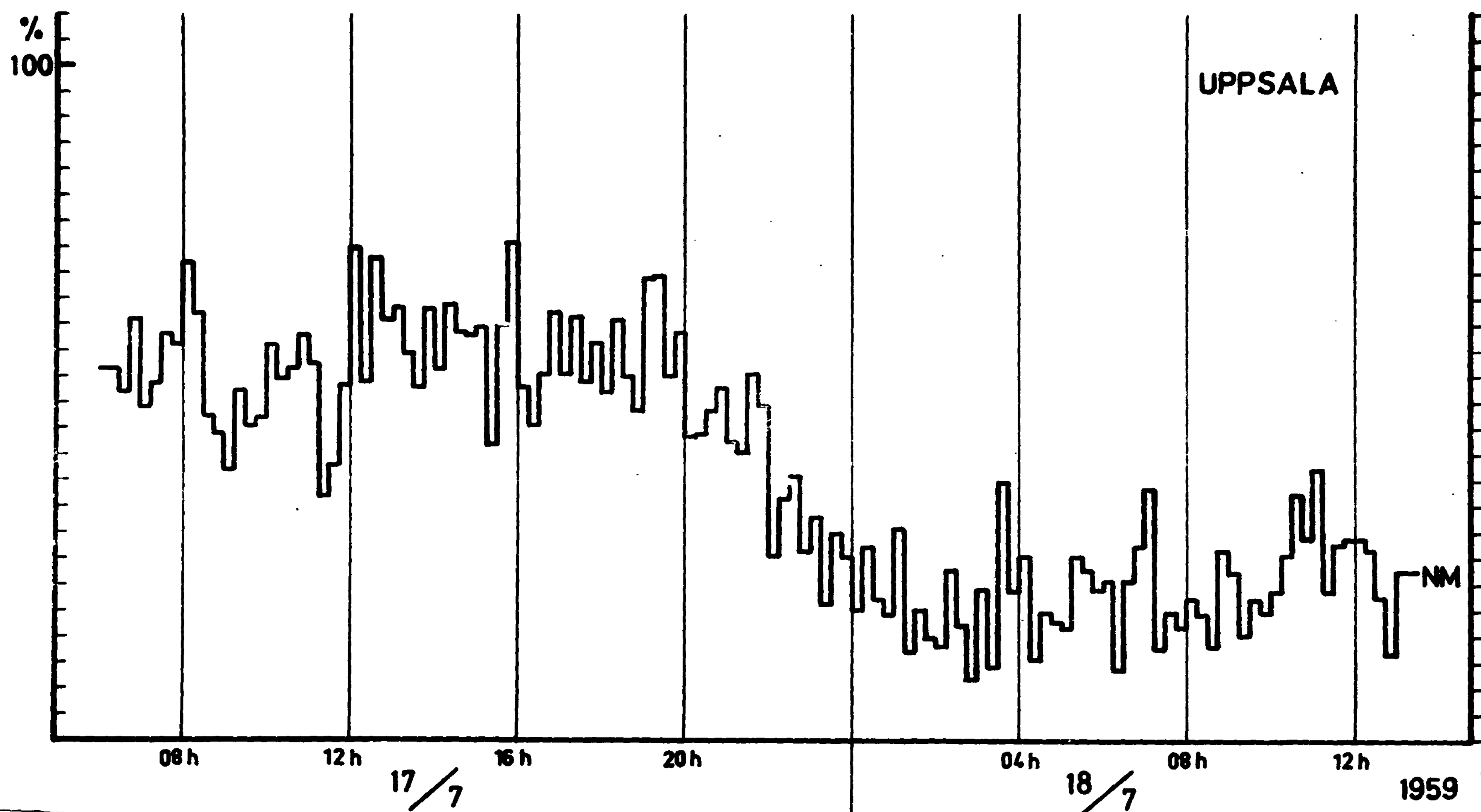

KIRUNA
%
100
100
100
Z
N
S
*
15/7
16/7
17/7
18/7
19/7
1959
B 25


%
100
100
100
100
100
NMU
ZU
EU
WU
ZK
16h
20h
11/7
12/7
1959

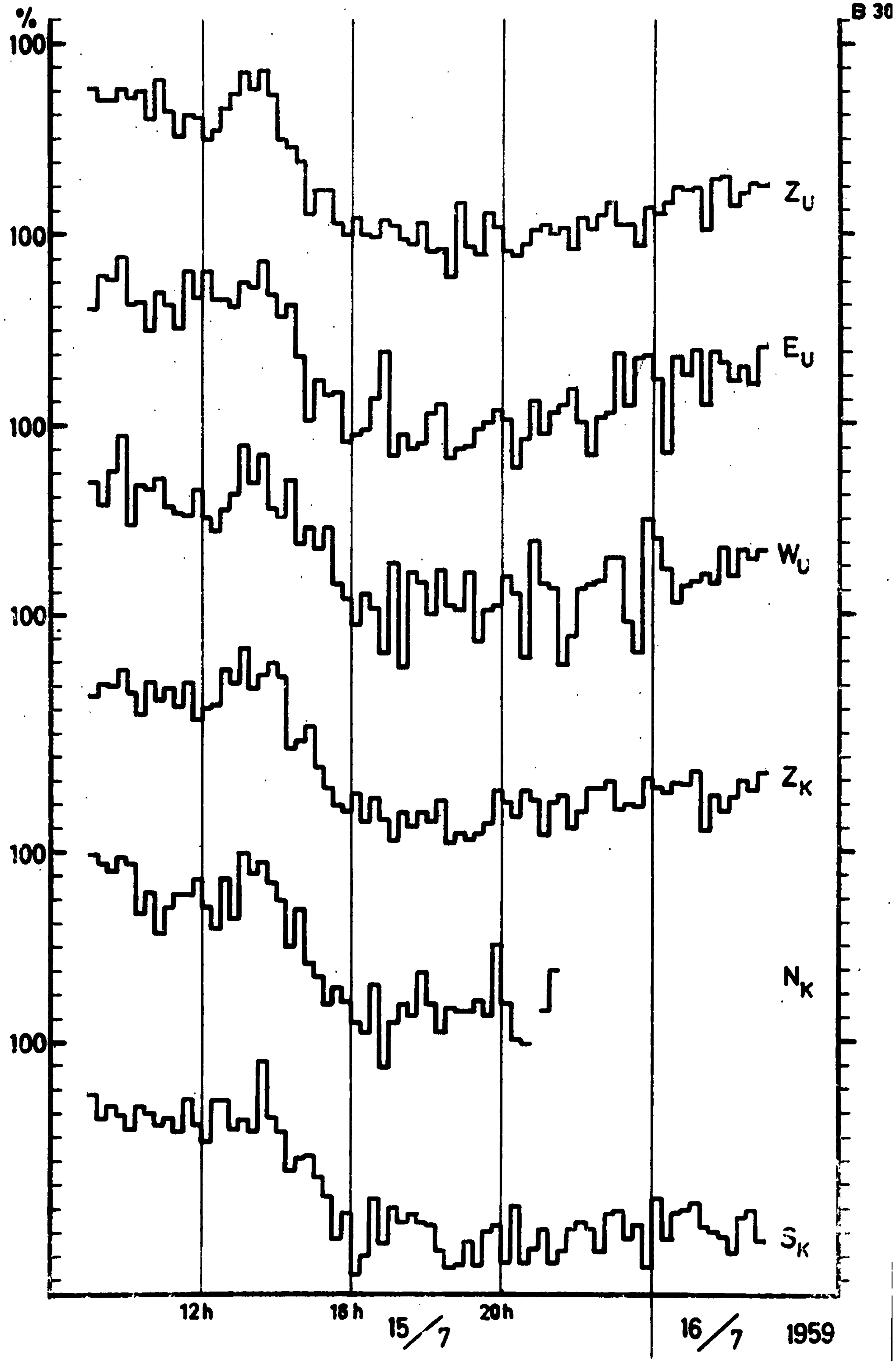
B 27



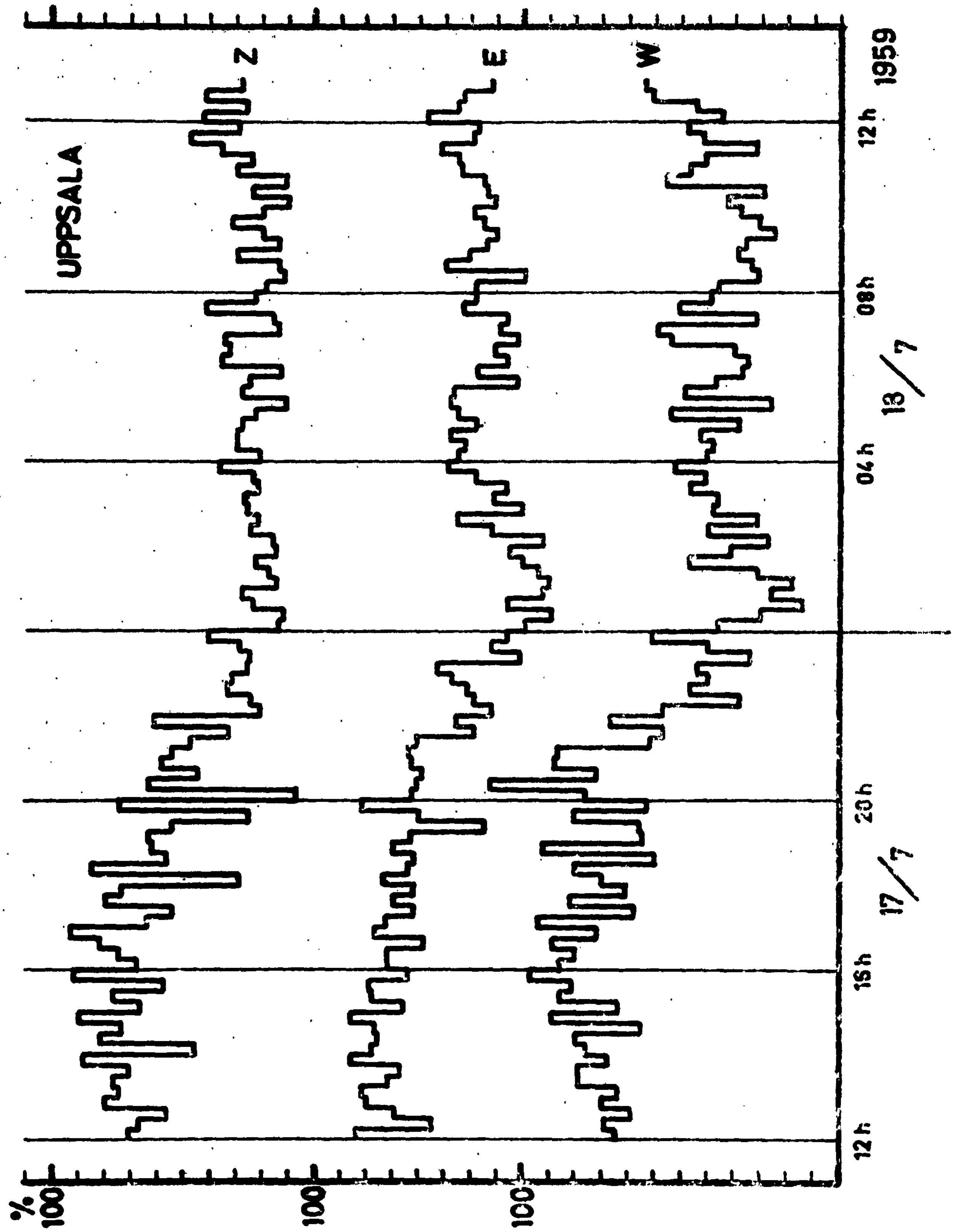

UPPSALA
NM
1959
17/7
16/7
08h
04h
20h
16h
12h
08h
%
100

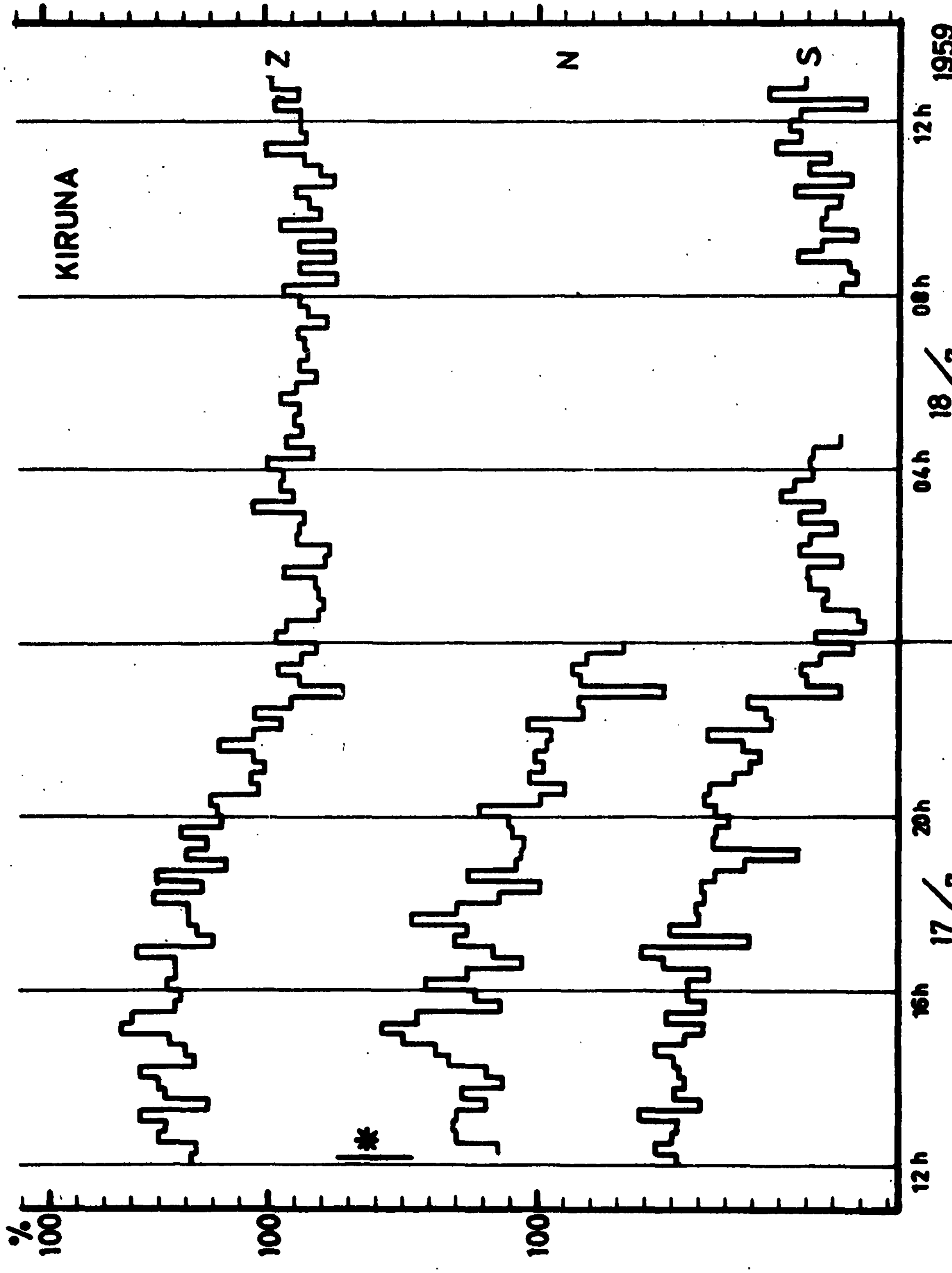


%
100
UPPSALA
NM
08h
12h
16h
20h
04h
08h
12h
17/7
18/7
1959
B 29

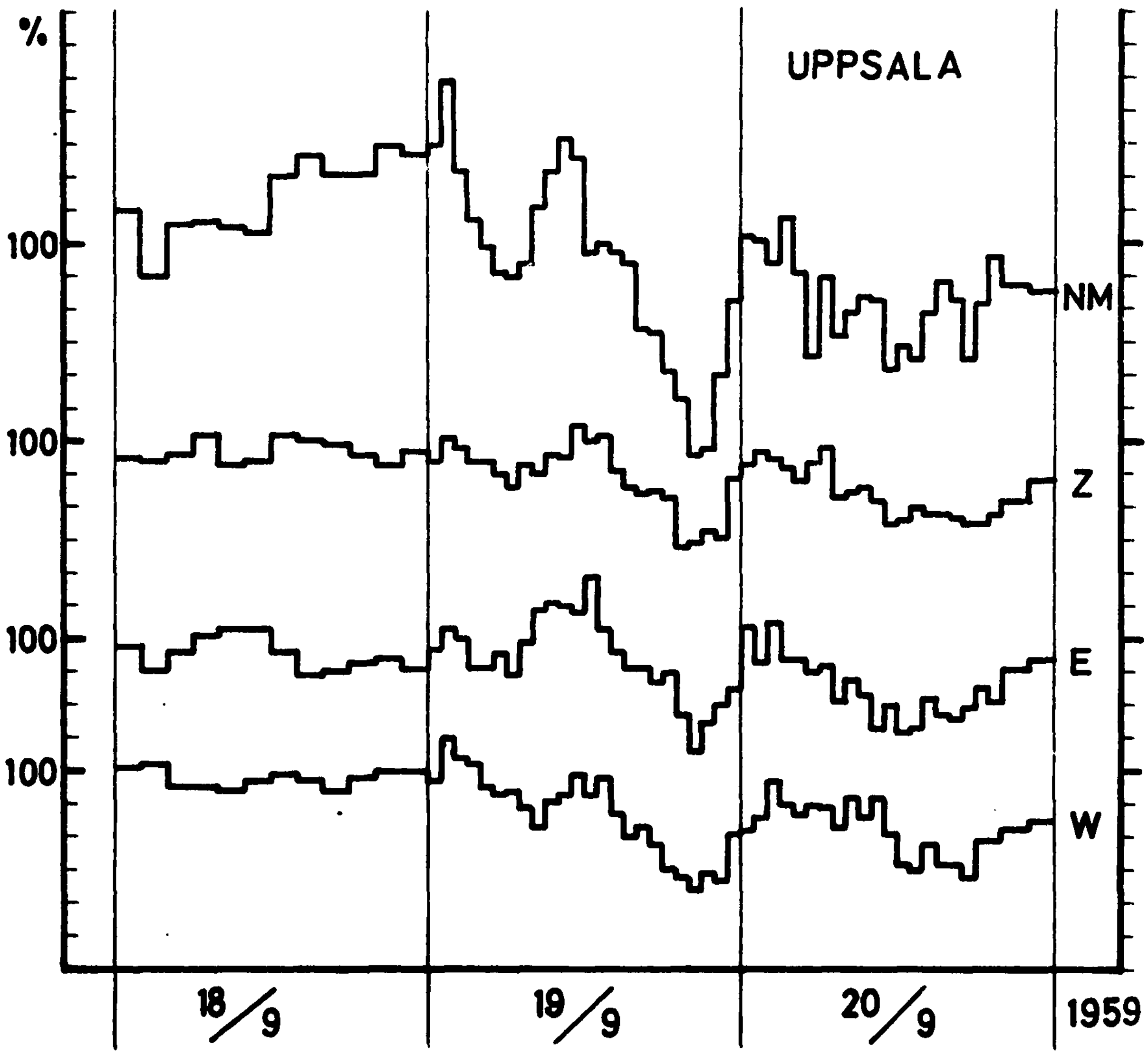


B 30
%
100
100
100
100
100
100
Z_U
E_U
W_U
Z_K
N_K
S_K
12h
16h
20h
15/7
16/7
1959


UPPSALA
Z
E
W
1959
%
100
100
100
12 h
16h
20h
04 h
08h
12 h
17/7
18/7



KIRUNA
Z
N
S
%
100
100
100
12 h
16h
20h
04h
08h
12h
17/7
18/7
1959


%
UPPSALA
100
100
100
100
NM
Z
E
W
18/9
19/9
20/9
1959

4. Remarks

In the majority of cases very little is gained by turning from bihourly to hourly or quarter-hourly diagrams. The almost complete survey of Forbush decreases referred to 1-hour periods was undertaken partly to ascertain how far a higher resolution will furnish any further information with a maintained combining rate. From a comparison between the bihourly diagrams A 1 - A 116 (Techn. Note No. 4) and the examples on hourly diagrams in Figs. B 1 - B 25 it can be found that it is difficult to tell from the bihourly diagrams if further details really are revealed by the increased resolution. Some general rules are confirmed which are mostly of a selfevident nature.

The quarter-hourly diagrams are of value only when the intensity variations are very rapid. Sometimes, despite the statistical fluctuations, one gets the impression that irregular and rapid intensity variations take place during several of the decreases included in the quarter-hour studies.

As no texts have been attached to the figures some comments on the diagrams B 1 - B 33 are offered here:

F.d. Nov. 11, 1956 (A 3, B 1) was remarkable because of the fact that there was no return after the C.R.S. to the intensity level before the decrease. The short stretch of hourly values reveals that the F.d. took place in two steps separated by at least one hour. This is confirmed by the quarter-hourly values, which by themselves do not offer very much more information. Bihourly values were included in the diagram to emphasize the unusually abrupt start and end of the decrease.

F.d. Dec. 25, 1956 (A 4 , B 21):The hourly values were computed with regard for the intensity increase before the F.d. as well as for fixing the onset time. They were computed for too short a period, really. Bihourly values were accordingly included to complete diagram. The steep gradient in the nucleonic component is verified and located to within one hour.

F.d. Jan. 21, 1957 (A 6-7, B 2-3): This is one of the most prominent decreases during the reported period. It is one of the cases where the quarter-hourly diagram is of real value.

F.d. April 17, 1957 (A 11, B 4): The nucleon component diagram is of interest because of the predecrease.

F.d. June 30, 1957 (A 14, B 4): The diagram of the nucleon component offers further details concerning the predecrease as well as concerning the region of increased intensity on July 1. In the bihourly diagram this maximum was indicated by practically only one single point. In the hourly diagram a gradual increase is indicated.

F.d. Aug. 4, 1957 (A 15, B 4) reveals that the impression of the location of the onset time depends on the width of the counting interval.

F.d. Aug. 29, 1957 (A 16, B 5): This is one of the really prominent decreases. Details appear well separated in the hourly diagrams of the nucleon component. The decrease took place immediately after the start of the Murchison Bay station. The equipment of the latter was not as yet operating to its full extent. Accordingly the quarter-hourly diagram from the latter station is missing. The corresponding diagram for the nucleonic component of Uppsala is reproduced.

F.d. Sept. 13, 1957 (A 19-21, B 6): This is a very peculiar decrease. The figure contains hourly diagrams from all the records obtained in Uppsala, Kiruna, and Murchison Bay. Unfortunately the E and W directional telescopes at the latter place suffered a complete break-down during the decrease. In the bihourly diagrams a very narrow but prominent minimum appears in the records from Uppsala and Kiruna. It is located to the period 06-08 on Sept. 13. It is less prominent in the bihourly records from Murchison Bay. Turning to the hourly diagrams we find it as prominent in the record of the nucleonic component at Murchison Bay as in the records from Uppsala. As concerns the meson component the minimum is less conspicuous in the hourly diagrams as compared to the bihourly data. The gain by using hourly data indicates that quarter-hourly data ought to have been computed at least as far as the nucleon component is concerned. Unhappily, as the decrease

was regarded small and insignificant the quarter-hourly data for this decrease were not included in the general survey.

Decreases on Sept. 21 and 22 (A 22, A 24, B 7): In this instance a prominent F.d. was followed by a second prominent decrease with an interval of only 24 hours. The second decrease had a very steep gradient which latter can be located within one hour by means of the hourly diagrams. Both decreases were associated with s.s.c.:s.

F.d. Sept. 29, 1957 (A 25, A 27, B 8): This is a remarkably steep decrease, at least according to the bihourly diagrams from Uppsala. Its character is retained in the hourly diagrams indicating that here, too, quarter-hour values ought to be computed.

F.d. Oct. 21-22, 1957 (A 28-30, B 9-10): The hourly diagrams offer more details than the bihourly diagrams concerning particular variations. The minimum at midnight Oct. 22-23 is verified. It is prominent in the Uppsala and Kiruna records but disappears almost in those from Murchison Bay. The decrease of the nucleonic component displays differing characteristics in Uppsala and Murchison Bay.

F.d. Nov. 26, 1957 (A 31, B 11): This decrease took place during a prolonged period of geomagnetic unrest. It was preceded by several s.s.c:s.

F.d. Febr. 11, 1958 (A 38, A 40, B 12): The early part of this C.R.S. is interesting because of the intensity increase following closely upon the F.d. A registration failure destroys part of the nucleon component records from Uppsala. What remains suffices to show that relative to the original intensity level the increase was bigger in Uppsala than in Murchison Bay.

F.d. March 17, 1958 (A 41, B 13): This F.d. was of an unusually short duration. W_U, N_K, and S_K are excluded (inferior statistics due to channels being out of order, Techn. Note No 4, Table 3). The quarter-hourly diagram from Uppsala might be of some interest. It displays variations four to six times bigger than the statistical fluctuations. Considering that there is quite a number of them it appears as impossible that they should all be accidental.

F.d. March 25, 1958 (A 42-44, B 14-15): The quarter-hourly values were computed because of the very steep decrease displayed by the nucleon component at Murchison Bay. For once the diagram makes it possible to locate the onset time with an accuracy of $\pm$ 15 min. This is true for Uppsala too. As concerns the meson component the onset time is not as easily determined. In some instances the computation of quarter-hourly values ought to have been extended for another hour before the start of the decrease.

F.d. May 29, 1958 (A 46, A 48, B 16): As regards the nucleon component the bihourly diagrams indicate a rapid decrease at Murchison Bay but a slow one in Uppsala. The difference is less conspicuous in the hourly diagrams. It might not be real.

F.d. July 8, 1958 (A 52-54, B 17, see also Part I, sec. 5): As compared to the nucleon component the decrease of the meson component is unusually prominent.

F.d. Aug. 24, 1958 (A 59, A 60, B 17): The F.d. has a very marked minimum region in the nucleon component.

Note that in Fig. B 17 the dates are wrongly given as Aug. 24 and 25; should be Aug. 23 and 24 (23/8 and 24/8, compare bihourly diagrams).

F.d. Oct. 23, 1958 (A 66, A 68, B 18): Hourly diagrams are reproduced for a period of three days. It is possible that three decreases took place, one on each one of the days Oct. 22, 23 and 24. This is most clearly indicated by the hourly diagram of the nucleonic component at Murchison Bay. s.s.c:s can be associated with each one of the three decreases.

F.d. May 11, 1959 (A 93-94, B 19-21): This was one of the most prominent decreases during the period treated in this note. At the time the standard cubical meson telescopes were not working properly in Uppsala. Therefore,

the Z-records had to be excluded from the bihourly diagrams. However, quarter-hourly values are available for the decrease itself. They have been included in Fig. B 21. On April 30 the generators at Murchison Bay had to stop owing to lack of fuel. Thus, there are no records from Murchison Bay beyond this date.

Note that between May 10 and 11 there was a change in the counting rates of the E and W telescopes in Uppsala. This explains the low per centages in the hourly and quarter-hourly diagrams compare bihourly diagrams in Techn.Note No.4)

F.d:s July 11, 15, and 17, 1959 (A 96-99, B 22-32): As complete hourly records as seems adequate have been given of this rather famous series of three prominent decreases. The Kiruna records are incomplete owing to registration failures and changes of counting rates. Concerning the nucleon component quarter-hourly diagram is reproduced for the whole period 15 d 18 h - 18 d 13 h. From practical reasons this period had to be devided into three parts. They are overlapping and drawn so as to make it possible to cut and stick them together. As in the bihourly diagram all through the whole period the intensities are referred to the same mean value before the first one of the three decreases.

F.d. Sept. 9, 1959 (A 107, B 33 : This is one of the decreases with a prominent minimum region of short duration. There is also a very interesting predecrease.

5. Errate to Figs. A 52 and A 54 in Techn. Note No 4

In Fig. A 52 a sudden increase is indicated during the period 14-16 on July 10. The quarter-hourly data show that most of this increase is due to the abnormally high counting rate during one single period 15 h 15 m - 15 h 30 m. For the other seven quarter-hours the mean value is 96.9 per cent. This will probably approximate the true value for the whole bihourly period.

The bihourly diagram of the nucleon component (NM_{MB}) in Fig. A 54 exhibits a prominent drop at the beginning of the F.d. (period 08-10 on July 8). There is no similar drop in the NM-curve from Uppsala. When computing the hourly diagrams it was found that the true value for the period 08-10 is 101.0 per cent.

PART II: A STUDY OF SOME DETAILS IN FORBUSH DECREASES.

1. Introduction

The records originate from three stations on approximately the same geographic meridian and from eleven separate instruments. They furnish data for comparisons between the F.d:s observed for primaries entering the magnetic field of the Earth in as many fairly well separated regions. Based upon the theoretical work by Brunberg (1958) these regions are being computed by E.Å. Brunberg and G. Ohlsson (Royal Institute of Technology, Stockholm). The results will be available within the next few months. Therefore, such discussions will be postponed which concern problems demanding a knowledge of the acceptance cones of the instruments. The points to be discussed here are the simultaneity in the various records of maximum and minimum intensity, the ratios between the intensity variations of the meson and nucleon components in Uppsala and Murchison Bay, the lapse of time between certain details of the C.R. storms and the associated s.s.c:s, and the relative positions of the s.s.c:s and the onset times.

When not otherwise stated the bihourly diagrams (Techn. Note No. 4) have been employed, mainly for the purpose of including, also, small and insignificant decreases.

Due to the character of the studies it has been necessary to exclude some records suffering from changes in the normal counting rate of the meson telescopes.

2. Definitions

The point of maximum before the F.d. is easily defined in those cases where there exists a distinctive increase of the intensity previous to the F.d. itself. (for instance Figs. A 6, A 42, A 96 and others in Techn. Note No. 4). Such a maximum point is usually situated within the last 24 hours before the decrease. In other cases it is difficult to tell if the maximum is not due solely to the statistical fluctuations (A 26, A 40, A 75). Nevertheless, in such cases the recorded maximum has been chosen for the comparisons in sec. 3. It becomes even more difficult to judge the position of this point when the F.d. is small and insignificant (for instance the z diagram in Fig. A 77). Here, too, the recorded maximum has been chosen even when it is of the same order of magnitude as the statistical fluctuations.

The definition of the first minimum after the decrease appears selfevident. However, it has to be emphasized that the original downward slope should be definitely over. For instance, the records of the decrease on Sep. 13, 1957 (A 19, A 20, A 21) display an extreme minimum dividing the gradient into two sections. This unusual phenomenon should certainly not be regarded as the first minimum following the end of the downward slope of the F.d. In other cases the judgement becomes difficult because of the steep part of the slope being followed by a sort of "foot" when the statistical fluctuations might create a false minimum. The recorded minimum intensity has then been accepted it being understood that mistakes as to the position of the true minimum will be mirrored by the distribution of values.

The absolute minimum does not need any special definition except concerning cases where decreases closely follow one after another (for instance A 22). These have then been regarded as one event. Naturally, such series of events as those in July 1959 (A 96 - A 102) have been treated separately.

The time of the maximum gradient is defined as the middle of the period exhibiting the greatest decrease of intensity. The selected period does not necessarily have to be a single bihourly period as a succession of 2-hr values might disclose that inside the statistical fluctuations, the gradient has been constant over more than one bihourly period.

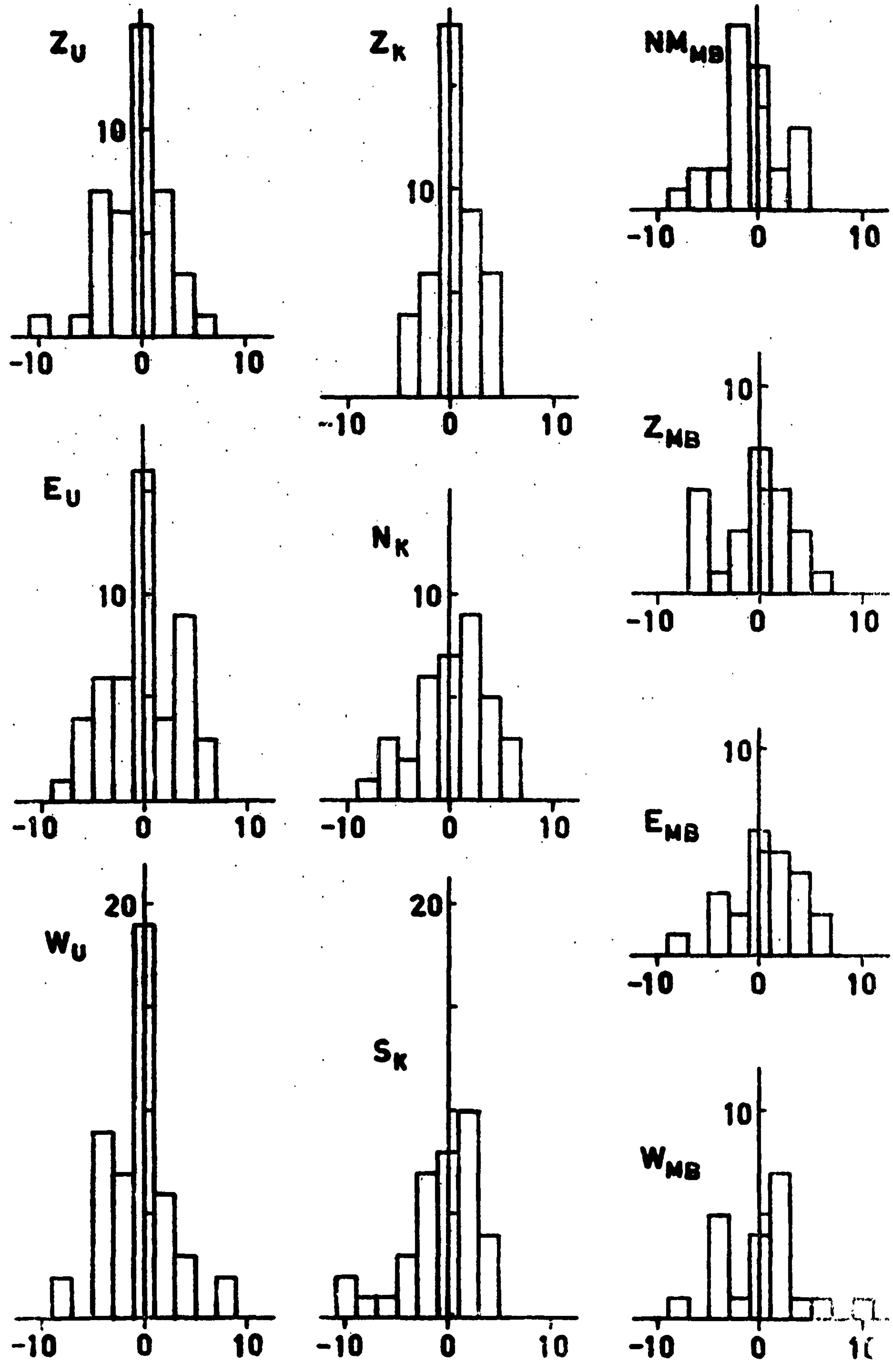


Fig.1 Distributions of the points of maximum intensity.

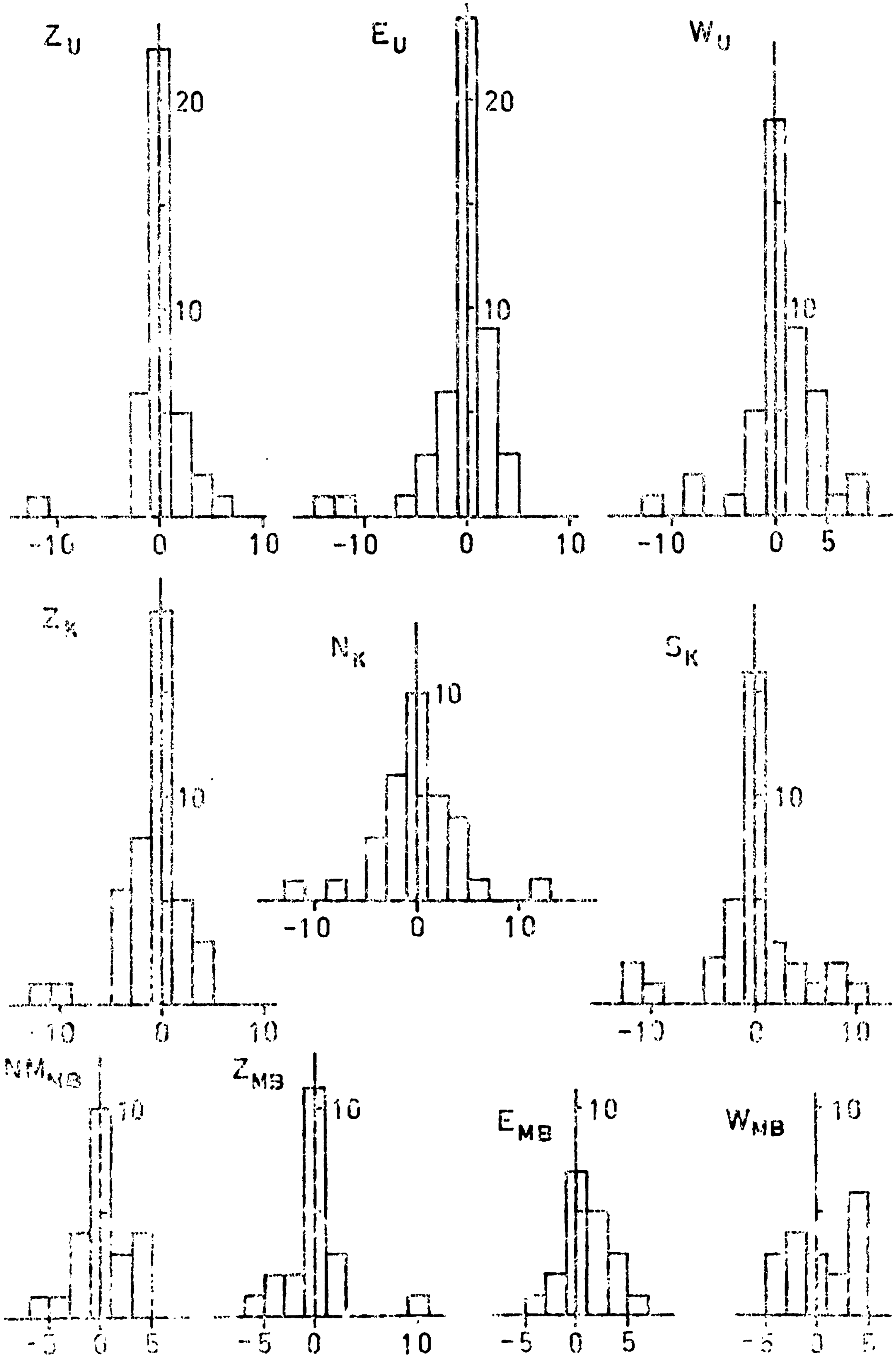


Fig. 7 [illegible] of the first minima of intensity following [illegible]

3. Time differences in the records of the meson and nucleon components during C.R.S:s

The records from the neutron monitor in Uppsala were selected as normals. The time differences were computed between the points of maximum intensity, the first minimum, and the absolute minimum in these records and the corresponding points in the various diagrams of the meson component from Uppsala, Kiruna, and Murchison Bay. Concerning the latter station the nucleon component was included in the survey. As bihourly values were employed we cannot expect the accuracy to be better than $\pm$ 2 hrs. Accordingly, bihourly intervals were selected for the histograms in Figs. 1 and 2.

The variations in the position of the maximum are described by the histograms in Fig. 1. Considering the limited number of events the distributions around zero difference is to be regarded as good. The mean values of the time differences are to be found in the first row of Table 17. They are all less than the expected minimum of the limits of error.

Fig. 2 contains the corresponding histograms for the position of the first minimum. The mean differences are tabulated in the second row of Table 17. In this case, too, they are less than the expected minimum value of the limits of error. The inclined directions at Murchison Bay excepted, there is a considerable concentration of values around zero. Concerning the former the small number of observations might explain the inferior distribution. However, in the other cases there are some instances of very big time differences. Some of these seem to be real as far as the actual intensity values are concerned. Nevertheless, this does not counteract the general impression of simultaneity as the discrepancies can be due to an influence from the phase differences of the daily variation.

Table 17

	Z_U	E_U	W_U	Z_K	N_K	S_K	NM_{MB}	Z_{MB}	E_{MB}	W_{MB}
Maximum intensity	-0.6	0.4	-0.3	0.1	0.1	-0.7	-1.0	-0.5	-0.3	0.4
First intensity minimum	0	-0.5	0.5	0.7	0	-0.2	0.2	-0.1	-1.0	0.4

We know also that the amplitude and character of the first harmonic varies from day to day especially during the C.R.S. following upon a F.d. Sometimes the discrepancies are due to the fact that the F.d. itself and its details are more difficult to locate in the records of the meson component than in those of the nucleon component.

The diagrams were scrutinized in all cases of extreme discrepancies. In that way discrepancies would be traced which obviously are due to statistical fluctuations. When also those are disregarded which possibly are due to the causes discussed above, there remains at least two instances, where a real difference is indicated. These are the decreases on Aug. 29, 1957 and May 11-12, 1959 (A 93, A 94). These are both among the most prominent events. For the time being further comments will be reserved as a through analysis of such events is to be attempted.

As concerns the absolute minimum we also find a concentration of the time differences around zero. However, as is to be expected the spread of the values is considerable. This is almost entirely caused by those cases where the minimum is flat and the influence from the statistical fluctuations becomes important. Generally, a direct comparison of the diagrams confirms the simultaneity of this detail.

4. The ratios between the intensity time variations of the meson and nucleon components during C.R. storms

During the numerical treatment of data, now in progress, cases have turned up when it was desirable to know, at least approximately, the ratio between the

variations in the nucleon and meson components. This led to a study including most of the decreases listed in Technical Note No. 4. Naturally those have to be excluded, which suffer from registration failures or from changes in the normal counting rate level. The discussion in the preceding section concerning the simultaneity of details led to the conclusion that there might exist a general correlation between the variations in the two components during C.R.S:s. However, it is not to be expected that such a correlation is mirrored in all details revealed by the bihourly data. For one thing there is the diurnal variation with its changes of phase and amplitude. Accordingly, daily means were employed instead of the bihourly values.

The first procedure was to normalize the counting rates to a common level. For convenience this was done by referring the data to the daily means $\bar{\bar{N}}$ of the same periods which were used for the 100 per cent levels of the diagrams A 1 - A 117 (Techn. Note No 4). In this way we have:

$$I = 100 \cdot \frac{N}{\bar{\bar{N}}}$$

$$\delta I \text{ meson} = q \cdot \delta I \text{ nucleon} \quad \text{- - - - - - - - - - - - - - - - - - - -} \quad (1)$$

The same value of q was not expected for all the F.d:s. For instanse, decreases appear sometimes in the nucleon component without any trace of them in the meson component (Figs. A 10, A 62). In other cases the meson diagrams seem to be almost parallel to that of the nucleon component (Figs. A 78, A 80). Therefore it is natural that the coefficient q has a spread between 0 and 1. However, there is a considerable concentration of values around the means collected in Table 18. These refer only to prominent decreases or decreases which appear well developed in the meson as well as in the nucleon component. According to the classification adopted by Bachelet et.al. most of them belong to classes I and II (Bachelet, Balata, Conforto, and Marini 1960). For comparison the numbers of the corresponding diagrams (Techn. Note No. 4) are given in the first column. This makes it possible, also, to identify the decreases (Table 2, Techn. Note No. 4). The standard errors were also calculated. As concerns the values in Table 18 the error varies between 5 and 20 per cent of the coefficient. Values marked with an asterisk are exceptions. In these cases the standard error exceeds 20 per cent. In one single case, marked with a double asterisk, the error exceeds 50 per cent.

Table 18. The coefficient q for prominent and well defined F.d:s

Fig.	Uppsala			Murchison Bay		
	Z	E	W	Z	E	W
A3		0.39^x	0.32^x			
A4		Rf	0.43^x			
A6-7		0.53	0.44			
A9		0.49	0.48^x			
A14	0.56	0.59	0.57			
A15	0.48	Rf	Rf			
A16-17	0.40	0.38	0.40			
A22. A24	0.55	0.32	0.32	0.37	0.44	0.40
A28. A30	0.51	0.47	0.53	0.41	0.38	0.41
A42, A44	0.46	0.41	0.37	0.41	0.36	0.44
A46, A48	Rf	0.48^xx	0.34^x	0.47	Rf	Rf
A52	Rf	0.47	0.51			
A96-97	0.38	0.34	?			

Table 19 contains the results from small decreases which are clearly visible also in the records of the meson component. Those decreases which are impossible or very difficult to detect in the meson component are collected in Table 20. In many of these cases the F.d. would not have been observed if only the meson records had been available. It is characteristic for the values in Tables 19 and 20 that the standard error is very big.

Table 21 contains the values of the coefficient q from decreases which appear to be combined with a slow change of intensity accompanying a prolonged period of geomagnetic unrest. A typical example is the F.d. represented by Figs. A 31-34 (Techn. Note No. 4). With this division according to type it can not be avoided that some decreases could be listed in Tables 19 and 20 as well as Table 21. .. Thus the F.d. Figs. A 78, A 89 could be referred to Table 19. However, this is the most typical instance of the nucleon and meson diagrams being almost parallel. The coefficient has a very high value.

Table 19. Coeff. q for small decreases distinguishible also in the meson component

Fig.	Uppsala			Murchison Bay		
	Z	E	W	Z	E	W
A8		0.54	0.56^{x}			
A12	0	Rf	Rf			
A57-58	0.31^{x}	?	0.42^{x}	?	0.42	0.49
A59-60	0.46	0.35	0.25	?	0.56	0.22
A62-63	0.42^{x}	0	0.21^{xx}	Rf	0.27^{xx}	0.64^{x}
A64-65	0.49^{x}	0.58	0.58^{x}	0.70^{x}	0.42^{xx}	0.55^{x}
A69-70	0.90^{x}	0.71^{x}	0.80^{x}	Rf	0.34^{xx}	0.26^{x}
A75, A77	0.45^{x}	0.48^{x}	0.43	0.52	0.46	0.48
A90, A92	?	0.50^{x}	0.58^{x}	0.57^{x}	0.58^{x}	0.56^{x}
A110	0	0.27^{xx}	0.48^{xx}			
A112	0	0	Rf			

Table 20. Coeff. q for decreases not distinguishible in the meson component

Fig.	Uppsala			Murchison Bay		
	Z	E	W	Z	E	W
A10		0	0			
A61	Rf	Rf	Rf	0.20^{xx}	0	0
A62-63	0.42^{x}	0	0.21^{xx}	Rf	0.27^{x}	0.64^{x}
A66, A68	0.29	0.41^{x}	0.46^{x}	Rf	0.32^{x}	0.21
A90, A92	Rf	0.50^{x}	0.58^{x}	0.57^{x}	0.58^{x}	0.56^{x}

Table 21. Coeff.q for decreases combined with a long period change of intensity

Fig.	Uppsala			Murchison Bay		
	Z	E	W	Z	E	W
A5		Rf	0.18^{x}			
A13	0.51	0.55	0.51			
A31-32, A31-34	0.33	0.36	0.39	0.43	Rf	Rf
A35, A37	0.63^{x}	0.56^{x}	0.60	0.40	Rf	0.37
A71, A73	0.45^{xx}	0.71^{x}	0.73^{x}	0.58^{x}	Rf	0.30^{xx}
A78, A80	1.07	0.71^{x}	0.86	0.76	0.72	Rf a)
A83				0.37^{x}	?	?
A84, A86	?	0.41	0.40	0	0.12^{xx}	0.12^{xx}
A87, A89	0.62^{x}	0.44^{x}	0.33^{x}	0.36^{x}	0.45^{x}	0.47^{x}
A105	?	0.58^{x}	Rf			

a) Probably a change in counting rate on Jan. 26

Decreases of a very short duration have not been included as they furnish to few points for the calculations. The most beautiful example of such a F.d. is to be found in Fig.A41. The other two excluded are those represented by Figs. A2 and A 45 (Techn. Note No. 4).

With due regard for the standard errors it appears permissible to form the means of the values in each one of the six columns of Table 18. As it is impossible to trace any systematic variations with the direction, the means have also been

Table 22. Mean values of the coefficient q.

	Z	E	W	Mean value for the station
Uppsala	0.47	0.44	0.45	0.45
Murchison Bay	0.42	0.39	0.42	0.41

formed for each one of the two stations. The mean values are to be found in Table 22. Despite the errors it has to be accepted as a fact that the coefficient has a lower value for Murchison Bay than for Uppsala.

The distribution of values in Tables 19-21 as well as the magnitude of the standard errors does not invite to the forming of means. It is possible that the decreases listed in Table 21 would furnish more consistant values if they could be separated from the long period intensity variation.

The coefficients in Table 22 should be used only when the decrease is prominent and takes place during a period without any complicating variations of the kind displayed by Figs. A 31 and A 78.

5. Storm sudden commencements correlated to Forbush decreases and C.R. storms

The center of this maximum gradient can be determined far better than the onset time. When comparing with the time of a s.s.c. we will therefore refer to the center of the maximum gradient. The lapse of time between a s.s.c. and the maximum gradient is in most cases sufficiently long to make the error insignificant even when the middle of the maximum gradient is being read from bihourly diagrams.

It happens that several sudden commencements precede a F.d., If the distances to the F.d. are considerable the most adjacent s.s.c. has been selected. There are some exceptions, i.e. when the most adjacent s.s.c. was observed by only a couple of stations while another one close by was recorded by more than five stations. Then the latter has always been preferred. When several s.s.c:s have happened one upon another very close to a F.d. the earliest one in the group has been preferred. A histogram of the time intervals between the s.s.c. and the maximum gradient, ($\tau_{F.d.}$ $\tau_{s.s.c.}$) is to be found in Fig.3.

The first minimum following upon the decrease can be regarded as the point where the C.R.S. has become fully developed. The variations of the time interval between the s.s.c. and the full development of the accompanying C.R.S. ($\tau_{C.R.S.}$ - $\tau_{s.s.c.}$) are illustrated by the second histogram in Fig. 3. In cases where the minimum was broad or too far from the F.d. the final end of the slope was selected as the point of complete development of the C.R.S.

The position of the s.s.c. relative to the point of maximum intensity, as defined in sec. 2, is described by the third histogram ($\tau_{m.i.}$ -$\tau_{s.s.c.}$) in Fig.3 The histogram reveals that in more than half the number of cases the S.S.C. preced the intensity maximum. This appears to dispose of the idea that, as a rule, the onset time coincides with the s.s.c.

The same is indicated by the histogram $\tau_{F.d.}$ - $\tau_{s.s.c.}$ which reveals the existence of at least two cases in which the onset preceded the s.s.c. One of these decreases was that of May 11-12, 1959 (A 93).

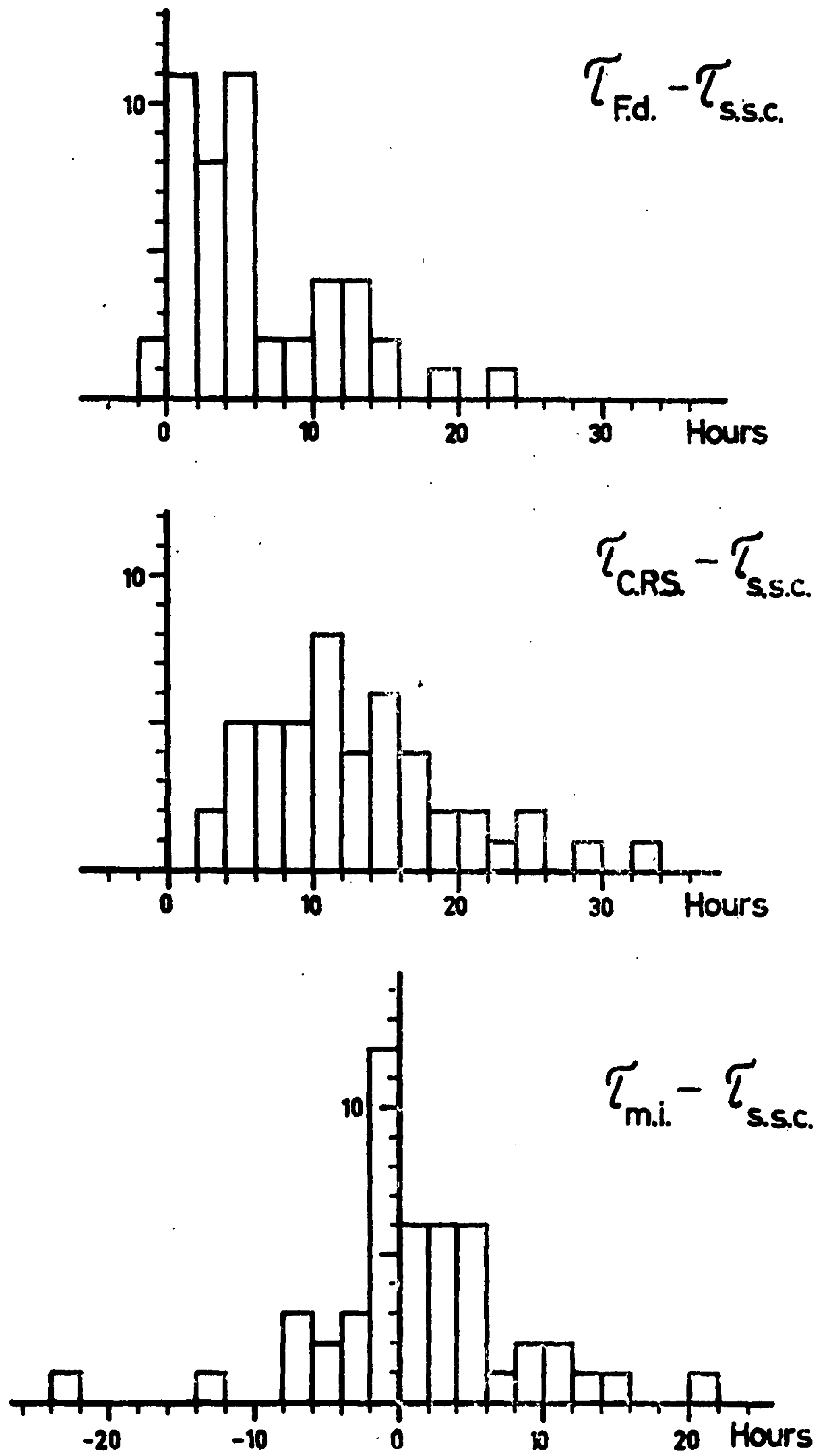


Fig. 3 Histograms of the time differences between s.s.c. and the maximum gradient ($\tau_{F.d.} - \tau_{s.s.c.}$), between the s.s.c. and the fully developed C.R.S. ($\tau_{C.R.S.} - \tau_{s.s.c.}$), and between the s.s.c. and maximum intensity before the C.R.S. ($\tau_{m.i.} - \tau_{s.s.c.}$).

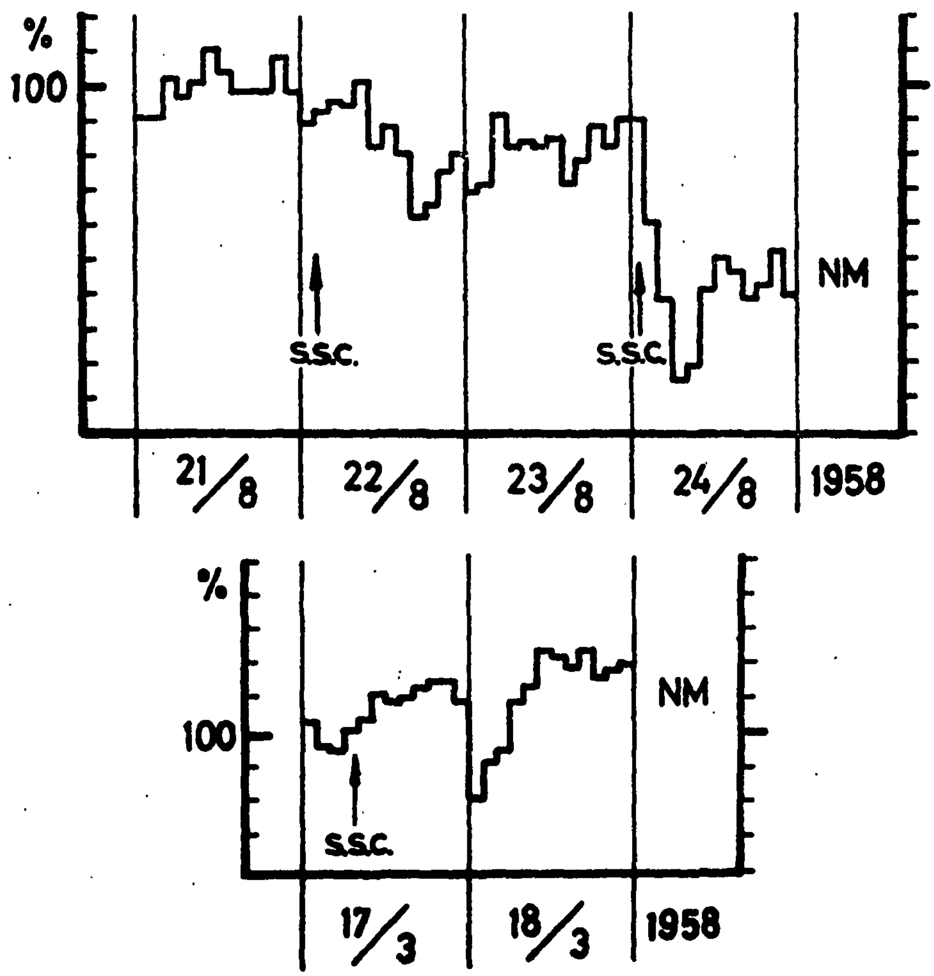


Fig. 4 The upper diagram illustrates a Forbush decrease with a predecrease. The lower diagram displays a Forbush decrease of unusually short duration in March 1958. The arrows indicate the sudden commencements

In the other case, June 28, 1958 there are two sudden commencements with a time difference of 10.5 hours. After the first s.s.c. there is a considerable intensity increase especially in the nucleon component. The F.d. is fairly prominent. It appears to start directly from maximum intensity with the second s.s.c. (6 ± 1) hours after this maximum. In this case it is possible that the decrease ought to have been correlated to the first one of the two sudden commencements.

The three histograms in Fig. 3 were constructed for future analyses of C.R. storms. They display an interesting distribution. $\tau_{F.d.} - \tau_{s.s.c.}$ shows that, if a F.d. is associated with a s.s.c., most probably it will follow the sudden commencement inside 6 hours. There is a second maximum of probability between 10 and 14 hours.

Concerning the lapse of time between the s.s.c. and the full development of the C.R.S. the histogram does not appear to have more than one maximum around 10 to 12 hours. There are only a small per centage of decreases where the lapse of time is more than 20 hours.

6. Predecreases and onset times

The widths of the decreases vary within wide limits. Accordingly no conclusion can be drawn from the histograms in Fig. 3 as to the position of the onset time relative to the s.s.c. In many cases the problem is complicated by the existence of a predecrease.

The predecrease might consist of a small drop in the intensity followed by a maximum before a well developed main F.d. Sometimes the intensity drop is lacking. In single cases the maximum can attain several per cent above the normal level. It is possible that a predecrease of the former type is a very badly developed F.d. of the ordinary kind. The C.R.S. of Aug. 22-30, 1958 offers an example (Figs.A 59 and A 60, Techn. Note No 4) of such a predecrease in the nucleon component. The meson component record (Z) from Uppsala reveals the true character of the predecrease. The upper diagram in Fig. 4 is a reproduction of the essential part of the NM diagram from Fig. A 59 with the s.s.c:s indicated which, beyond doubt, are associated with the two decreases. As in a few cases rather prominent decreases have been recorded without a preceding s.s.c., the absence of a s.s.c. in other cases does not contradict the assumption that a predecrease of the type in question really is a small F.d.

In the present case there is no doubt that each one of the two decreases has its own onset time. However, the fact that decreases follow closely one after another raises the question if the onset time of a later decrease cannot be displaced seriously by the intensity variations following upon the preceding one.

Sometimes the predecreases are created by an enhanced diurnal variation. This also is destructive as concerns the possibility of deciding the onset time. Mistakes of 6 hours are certainly possible if it takes place late in the diurnal cycle.

The histogram $\tau_{m.i.} - \tau_{s.s.c.}$ in Fig. 3 indicates that the s.s.c. and the onset time can be separated by many hours.

7. Remarks on the character of some C.R. storms

Bachelet et.al. have devided the C.R.S:s into three maj types (I,II, and III) according to the sharpness and steepness of the decrease (Bachelet, Balata, Conforto, and Marini 1960). Storms with a less well defined F.d. were collected in a fourth class. Type X. The gap between III and X is probably intended as space for further classes, should a more detailed classificati become possible.

The fact that there are decreases in the nucleon component which are lacking or very small in the meson component reveal an energy dependence. Possibly these storms ought to form a separate class.

The same can be said concerning the C.R.S:s of exceptionally short duration. Most of them are to be found during the recovery stage after a storm of normal length. They are characterized by a steep and, usually, small F.d. followed by a rapid recovery. These storms apparently follow the rule by Bachelet et.al. that

decreases taking place during the recovery stage of a C.R.S. will be small and insignificant as compared to the initial F.d. However, there are also a few single storms of short duration. The storm on March 17 - 18, 1958 (Fig. A 41, Techn. Note No 4) was not associated with any preceding storm although it took place during a period of increasing C.R. intensity. It is remarkable because of a well developed F.d. and a duration of only 12 hours. The storm next before started on Feb. 10. The reality of this C.R.S. is verified by its appearance with essentially the same features in the meson component not only in the records from the Uppsala station but also in the records from the C.R. stations at Kiruna and Murchison Bay. The hourly diagrams (Fig. B 13) offer further evidence as to the character of this decrease. They show, also, a distinctive difference as to details between the Uppsala and Murchison Bay records of the nucleon component. The quarter-hourly diagram of the latter reveals short period variations which certainly are not due solely to the statistical fluctuations. The bihourly record of the nucleon component in Uppsala is reproduced in Fig. 4 with the time of the associated s.s.c. indicated by an arrow.

A third type of C.R.S. has already been commented in the preceding sections. It comprises those storms where the variations are almost of the same magnitude in the two components. From the present material it appears as if this is a special case of the more common type where the F.d. takes place during a period of depressed intensity usually associated with a prolonged period of geomagnetic disturbances.

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